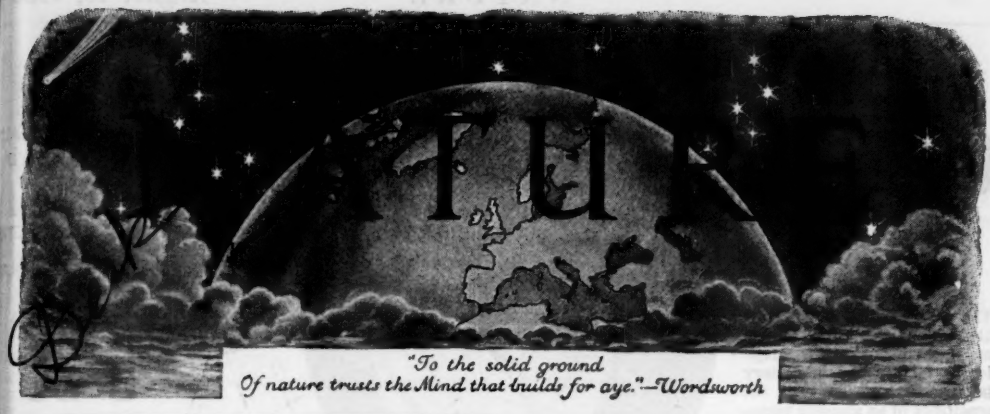

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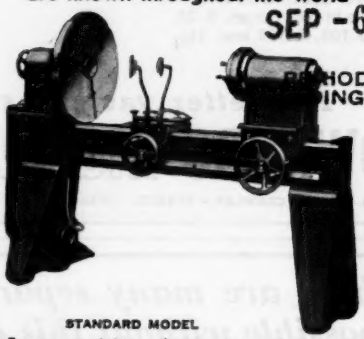

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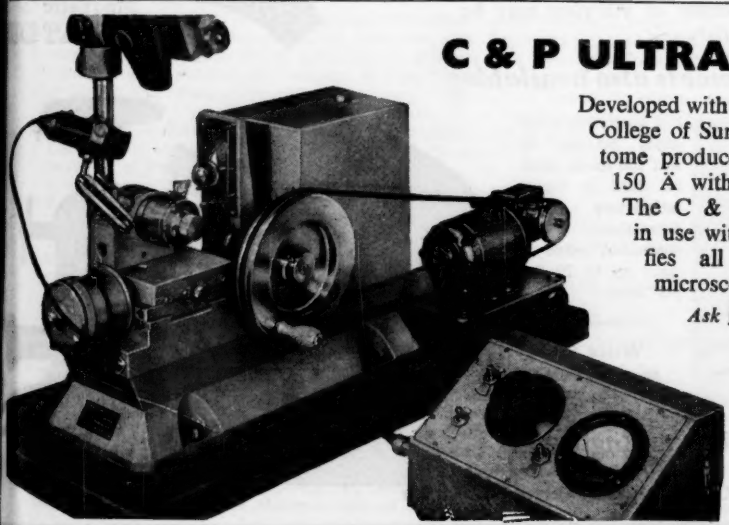

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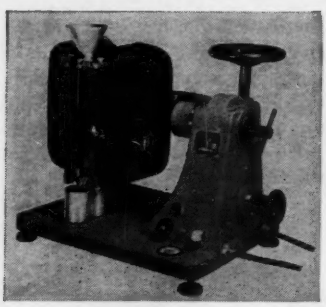

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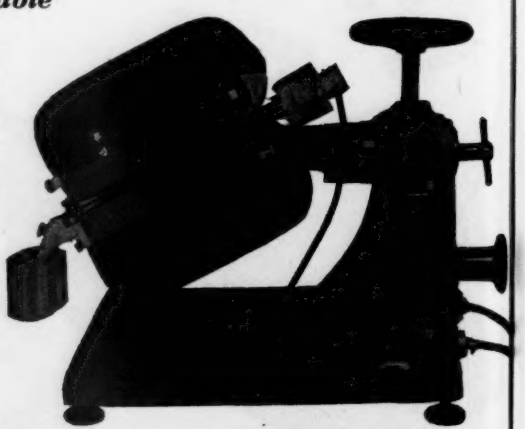

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NATURE

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A BALANCED EDUCATIONAL SYSTEM

THE debate on technical education in the House of Commons on June 21 drew from the Minister of Education and the Lord Privy Seal further details of the Government's plans for the development of technical and technological education in Britain (see *Nature*, 177, 1204; 1956). Sir David Eccles named eight colleges which he proposed to designate as colleges of advanced technology and indicated the probable geographical location of two more. Mr. R. A. Butler gave some figures for the proposed Government expenditure on buildings for university departments of technology and for higher technological education without, however, indicating clearly how far, or not, this overlaps with the building programme to which Sir David Eccles referred and which appears to cover the proposed colleges of advanced technology, to seven of which, as well as the Imperial College of Science and Technology, London, the Royal Technical College, Glasgow, and the Manchester College of Technology Mr. Butler specifically referred. The distinction between these three and the eight colleges of advanced technology which Sir David is proposing to designate is still not clear, except that, unlike the former, the latter colleges will confer diplomas in technology and not degrees.

The proposed Hives award was severely criticized in the debate. Sir David's defence of the decision to introduce this award was unconvincing and did not meet the reasoned argument in the debate that the institutions in which technological education is to be given should be in close relation with the universities and, if independent, should be capable of giving degrees in technology carrying the status of a degree given by a university department of technology. The objection to the diploma, however, would largely be avoided if more attention had been paid to the major professional institutions. The associateship and fellowship of these institutions are already regarded in industry and technology generally as having a status as high as that of a university degree. It is at least arguable that the new colleges of advanced technology would achieve the desired standing much more quickly if they relied either on such professional awards or on degrees conferred by an associated university rather than on a new award which, quite apart from the obvious prejudices it encounters at the start, must require many years to establish its standing.

Too much can be made of this point, however, for the real value of the award, by whatever name it is called, will depend on the value which industry places on the men who earn it. If they can hold their own with those now coming from the technological departments of the universities, from the Imperial College of Science and Technology, the Manchester College of Technology and the Royal Technical College, Glasgow, there will be no question of inferior status; but, as Mr. M. Stewart rightly said in opening the debate, it is no use calling a college a 'college of advanced technology' if it cannot do the work. The Minister, however, probably realizes already some of the difficulties, for he made perfectly clear in the debate that the conditions which a college must fulfil to qualify for designation as a college of advanced technology will be stringent, as is to be seen from the circular issued simultaneously (see *Nature*, June 30, p. 1204).

Manifestly, the Minister carried the House with him in all this. The real question is whether he was carrying concentration sufficiently far. It is, to say the least, doubtful whether Britain has, or can have in the next few years, the resources to establish ten new major technological institutions, considering not merely the problem of staffing them adequately but also of equipping them. Both geographical criteria and the criteria of standard of work might well be applied much more searchingly than Sir David appears to contemplate doing. To do so might, moreover, ease the solution of his other problem—that of autonomy. While Manchester has shown that local authorities can, and do, take a national view, it may well be questioned whether it is reasonable to expect them to do so; nor with the example of national parks administration before us can optimism be felt that the national interest will always prevail where it clashes with local desires. The complete free trade in students is far more likely to be assured if the colleges are given real autonomy, and without it there is reason for doubting whether they will attract staff of really high calibre. With a severely limited number of colleges of advanced technology, not only should there be more reasonable prospects of staffing them adequately but also there would be less over-riding of local interests. Local authorities would be able to demonstrate in the running of the technical colleges, particularly at the area and regional level, their ability to take wide views of their responsibilities.

The debate, which incidentally brought a further request for something on the lines of a Technological Grants Committee, as an independent body or a sub-committee of the University Grants Committee, showed that both sides of the House of Commons are now well aware of the danger of dissipating the educational resources of Britain, and also appreciate the importance of maintaining high standards and appropriate conditions of service to enable the new technological institutions to achieve their purpose. Moreover, in spite of something of a dichotomy between the colleges of technology and the university departments of technology in both Sir David's speech and in that of the Lord Privy Seal, there is a growing readiness to look at the expansion of technical and technological education as part of the expansion of education as a whole. This was apparent in Sir David Eccles's speech no less than in those from the Opposition benches; for although Sir David dealt mainly with technical education, he made it clear at the outset, not merely that we must avoid dispersing our resources, particularly of teachers, over too many

technical colleges, but also that we must try to keep a balance in the various advances we are trying to make between one part of the education service and another.

Sir David's speech was thus important as giving a clearer picture of the Government's general policy or structure in technical education. Broadly speaking, and leaving aside certain national colleges like the National Foundry College, the Minister said that there are at present three types of technical college, to which the White Paper proposed to add a fourth. First, there are in England and Wales some three hundred local colleges providing part-time or full-time courses up to the level of Ordinary National Certificate. These in the main train the technicians and craftsmen. Next, covering much the same ground but also providing more advanced courses, mostly part-time, come the area colleges, of which there are at present about a hundred and fifty. Many of these, however, are in need of expansion, and provision for this is made in the building programme to which Sir David referred later in his speech. Thirdly, there are the regional colleges, of which in a few years time there may be thirty. While these colleges would cover a good deal of the same ground as the area colleges, with more advanced work in the form of full-time or sandwich courses, some, such as the North Staffordshire Technical College at Stoke-on-Trent and the Treforest Technical College in Glamorgan, would provide advanced courses in single technologies which would be eligible for the 75 per cent grant. At the apex come the colleges to be designated colleges of advanced technology, which will concentrate entirely on advanced work, including postgraduate and research work, and which the Minister hopes to see built up to something like university status. Besides the eight colleges named in his speech, the Minister indicated that it is hoped to designate in the near future a college to meet the needs of the north-east coast, and also, if sufficient support is forthcoming from industry, the Bristol College of Technology, to meet the needs of the south-west.

If the Minister is to maintain his criteria of standards, it may become necessary to reduce this list and to revise it in order to meet the geographical criteria. Sir David was indeed optimistic as to the supply of teachers, which he admitted is the heart of the problem. He said that the figures for March 31, 1955, are really encouraging, showing about 10,000 full-time and 43,700 part-time teachers in technical colleges, an increase of 800 full-time teachers over the figures of the previous year. Of the part-time teachers, more than 11,000 are school-teachers employed part-time in colleges, most of the others, including many men and women of distinction, being employed in industry.

Sir David was also optimistic that industry would be able to help even more in supplying part-time teachers; but it is doubtful whether part-time teachers can make the contribution in advanced work that he expects. They can scarcely help to foster the residential community which the Minister obviously expects from the stress he laid on the provision of residential accommodation; indeed, the Government's reliance on part-time teaching is a weak point in the scheme, which unfortunately received little attention in the debate. Such teaching has its place, perhaps especially in postgraduate courses; but it has its limitations too, and its influence will be best felt when the part-time teacher is in a relatively small minority on the teaching staff. There is a place, too, for industrialists on the governing bodies of technical colleges, and particularly for men of technical knowledge.

It cannot be stressed too much that we cannot get an adequate system of technical or technological education in Britain on the cheap. There appears to be real danger in the Government's proposals that in trying to expand too fast at the top we may not merely lower standards but also carry into the new colleges something of the niggardliness and parsimony that have handicapped the technical colleges in the past and contributed to their difficulties in securing recognition by the public and in recruiting first-class staff. Moreover, Sir David Eccles did not justify his designations by any reference to the estimated relative demands of industry over the coming years for technicians and technologists, or to the probable increase in the number of 18-year olds in Britain from 640,000 in 1955 to 850,000 in 1965, in terms of either aptitude or inclination for technical and scientific careers. If £15 million for the building programmes for 1957–58 and 1958–59 which the Minister has now approved are wisely expended, the new technical colleges at all four levels should be much more efficient and productive places; though it may well be judged that the contribution to the supply of technicians will be larger and that to the supply of technologists smaller than the Minister expects.

The character and status of the teachers may be affected in the same way, though it should be noted that the Minister is already looking into the training of teachers for technical colleges and has asked the chairman of the National Advisory Council on the Training and Supply of Teachers and the chairman of the National Advisory Council on Education for Industry and Commerce to nominate a small joint committee to advise him urgently upon the recruitment and training of such teachers. He also indicated his awareness of the importance of salaries and other conditions of service, such as a more generous staffing ratio which affords opportunities for research and keeping in touch with industry; and, referring to the importance of the regional colleges and the colleges of advanced technology being available for all students, whether or not they lived in the area of the local authority responsible for the college, Sir David said that any restrictions, anywhere, must be seen to be very fully justified.

Sir David expressed confidence that complete agreement would be reached in the talks now in progress with the local authorities on this question. Even if his confidence is not fully justified, such agreement could well be helped by a much more vigorous Government campaign to persuade parents as to the opportunities and national importance of

careers in science and technology. Unless that is undertaken with much more vigour and imagination than has yet been apparent, it is doubtful whether the impending bulge of school-leavers will fill the new places in the science and technological departments of the universities, the colleges of technology or the technical colleges. Sir David himself stressed the importance of first-class public relations in a voluntary system of further education; but he was thinking rather of co-operation with industry and of securing the close personal interest of industrial management both in the technical college and in the schools from which its students are drawn. Mr. S. C. George rightly stressed the need for greater efforts to attract the abler boys and girls into such careers, and Mr. R. A. Butler was ill-advised to ignore Mr. George's request for an assurance that a virile and imaginative campaign would be waged within the schools and among parents to that end.

On the question of teachers, Mr. George, however, was inclined to agree with Sir David Eccles, quoting the opinion of the director of the Royal Technical College, Glasgow, that he does not doubt the ability of Scotland, at any rate, to provide the staff for the new colleges when they are built. Apart from this, there was little support in the debate for the Minister's optimism; though the plea for greater efforts to educate parents as to what is at stake for the industrial future of Britain and so to use their home influence to discourage early leaving was repeatedly echoed, notably by Mr. J. C. Jennings. Sir David, in fact, found a large measure of support, particularly in regard to his stress on the need for a balanced policy and for a liberal conception of education which would equip the young men and women entering industry with the adaptability and versatility which they would need.

The importance of this has been emphasized by recent events in the motor-car industry, and there are, of course, measures outside the field of education which the Government could use to encourage adaptability. Broadly, however, the debate showed a large measure of agreement that the magnitude of the Government's programme is about right, having regard to the resources at present available; but that there are serious reservations as to the deployment of resources, more particularly those going into the colleges of advanced technology. They probably should be fewer and more generously developed as regards amenities, staff and autonomy. Moreover, as regards technical colleges at all levels, there is much which could be done at slight expense to make them more effective and to remove the bleakness which hinders also the development of corporate student life.

Dr. F. Aylward, in a paper on education and industry published in *Chemistry and Industry* of May 5, which also stressed the importance of creating in the next few months an informed public opinion, in this connexion referred to the part which the common room and library play in a full education. The technical colleges, however, only too often possess inadequate libraries and reading rooms, comparing unfavourably with a local public library. These are the more important, however, when a large proportion of students are without the privacy for study in their homes and lodgings; and adequate budgets for technical college libraries would do much at small cost to increase the efficiency of the present colleges. Even here, however, the Government cannot wisely ignore the return which a national library system for science and technology, such as the Advisory Council for Scientific Policy has recommended, would bring.

In spite of the further information it contained, the Lord Privy Seal's speech replying on the debate was disappointing. Mr. Butler said that, in 1955–56, actual expenditure on technical education was £7 million, and the University Grants Committee has recently examined the building programme for 1957–59 with particular reference to technology. An increase of 60 per cent in student numbers is anticipated over the next five years, and the Government has already authorized further buildings to be started in 1957, not only for engineering and other technologies, but also for basic science, physics and chemistry, in which technologists require to be well grounded, at an estimated cost of £4·5 million. This figure does not include sums collected by the universities themselves, or the £15 million to be spent on the Imperial College. The London County Council has now given outline approval for the east and west blocks on the island site in South Kensington, and work can now proceed on that part of the plan; but the central part is regarded as somewhat overbuilding the site. The Council is, however, prepared to give permission for certain sites in Princes Gardens to be used for the provision of common rooms and refectories, and this would permit reduction of the density of development on the island site. A revised plan has been prepared which not only gives a lower density of development but also allows the central tower of the Collcutt building to be preserved by the College (see *Nature*, July 21, p. 123); it would be necessary, however, to obtain expert advice on the stability of the tower as a separate unit. It is also proposed to spend about £750,000 at Salford, about £1·5 million at Birmingham on the development of the technical colleges there, and further sums not only at Manchester, where the Corporation is reserving an area of 17½ acres for the development of the Manchester College of Science and Technology, but also at Bradford, Loughborough, the Chelsea Polytechnic and the Northampton Polytechnic in London, and the Cardiff College of Technology. £100,000 has been provided in 1956–57 for developments in Swansea Technical College.

Mr. Butler thus failed to meet the main points of criticism which, for the most part, were very reasonably advanced during the debate; nor did the information he gave indicate precisely the relation of the structure of technical education outlined by the Minister of Education to the university departments of technology, or the distinction between, for example, the Manchester College of Technology and the colleges of advanced technology. What seems beyond question is that the Government should acquire, as a matter of urgency, the factual information as to the nation's requirements in technicians

and craftsmen as compared with technologists and scientists, and that meanwhile it should be conducting with energy and imagination the task of public education essential to secure the co-operation of parents and of industrialists. Unless that task is vigorously undertaken and guided by real insight and understanding, it is idle to expect that 'early-leaving' will be reduced, an adequate proportion of the brighter boys and girls attracted into scientific and technical careers or that the understanding and co-operation of industry and local authorities will be fully engaged, either in the management of the technical colleges or in their staffing. If the Government is to rely on voluntary day-time release, much more must be done to bring home to industry its importance; just as the local authorities must be helped to understand the need for regional, if not national, views in running local and regional colleges and parents the need for encouraging young people to stay at school. It is the failure of the Government to deal vigorously and with foresight with these matters, and with those ancillaries like the national library, which contribute so much, directly and indirectly, to the full efficiency of the educational institutions of Britain, that justifies doubts as to whether the urgency and vital importance of a balanced system of education, in which technical and technological education find their appropriate place, are fully appreciated.

ROBERT HOOKE

Robert Hooke

By Margaret 'Espinasse. (Contemporary Science Series.) Pp. ix+192+16 plates. (London: William Heinemann, Ltd., 1956.) 21*s*.

IF a scientist who admittedly knew little of poetry were to write a book the chief aim of which was to defend Wordsworth against strictures from Byron and Shelley, the literary reviewers would, rightly, be savage in their attack. The scientists defend their realm less sternly. Of her biography of Hooke, Mrs. Margaret 'Espinasse writes: "My motive in the enterprise is my feeling for Hooke. . . . When I first read his Diary I was enchanted by the personality which seemed to emerge so clearly". This is a valid reason; but many people will find the sustained tendentiousness and lack of scientific depth both tedious and irritating, and those familiar with Hooke's work will wish for more information on it and less defence of his personality.

Hooke, like all the original members of the Royal Society, was a fascinatingly complex thinker and an excellent and original scientist, whose interest in science far outran the study of elasticity which has left us Hooke's Law: he worked in optics, dynamics, pneumatics, physiology, microscopy, horology and chemistry, and was a brilliant inventor and an excellent architect. He is very like Wren in his interests, as the author points out. The originality and inventiveness which Wren poured into architecture Hooke put, with equal success, into the less enduring field of mechanical invention. As Mrs. 'Espinasse rightly remarks, Hooke is particularly interesting as almost the only paid professional scientist of his day. He was lucky that his work aided his science, whereas most of his contemporaries were busy doctors, architects, business men, courtiers, men of affairs, or theologians, who could give only their spare time to science. Hooke, as curator of the Royal Society, was at the centre of a busy, vivid, stimulating intellectual circle, pulsating with ideas, regularly discussing all scientific subjects and advances, both those made at home and those reported from abroad.

Hooke disputed more about priority than the others, Newton excepted; as a professional scientist, it mattered more to him, and he was, besides, a touchy man, quick to feel slighted even by his best friends, and equally quick, usually, to make it up. But Hooke does not need the jealous defence here accorded him; nowadays we do not share the Victorian passion for heroes. We prefer a just appraisal of a man set fairly in his period, and modern scholarship of the past ten years (unfortunately little remarked here) has corrected the earlier Olympian view of Newton. We now know that Newton, like Hooke, was a discursive, experimental, inquisitive scientist, whose works are more systematic than his thought. Hooke, even more true to his age—less the formal mathematician, and more generous in publishing his scientific work (though he was more restrained in declaring his inventions, unfortunately) —eschewed systems. To-day we appreciate non-systematic scientists like Hooke and Huygens more than the eighteenth century could do.

There is much in this book to interest any reader; it is a pity that the author's judgments of Hooke's achievements are often faulty. The air-pump Hooke built is not a forerunner of the steam engine; nor was his nitro-aerial theory of combustion an anticipation of Lavoisier. On the other hand, his theory of light as pulsed waves is more modern, and much more interesting, than is indicated. The descriptions and appraisal of Hooke's mechanical inventions are more just and complete, and are supported by handsomely reproduced illustrations. It is to be hoped that this book will attract interest to the further study of Hooke and his contemporaries, so that we may properly appreciate our predecessors.

Marie Boas

ELECTRICITY IN GASES

Ionized Gases

By Dr. A. von Engel. Pp. x+281. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 42*s*. net.

SINCE the publications of Townsend and Thomson there have been few comprehensive books on this subject which achieve the same standards of clarity in elucidating the basic physical principles. Dr. A. von Engel's book is outstanding in this respect. In a modern work this cannot readily be achieved without considerable sacrifice, and in the present volume, as the author admits, simplifications have been made with consequent loss of detail.

The author states that the book is based on his lectures to undergraduates and, happily, this is true of its style as well as of its content. The result is a book which is delightfully pleasant to read, and makes good the promise in the preface to form an introduction to the subject.

The titles for the various chapters follow the almost inevitable pattern: excitation and ionization;

emission of charges from surfaces; mobility; diffusion; recombination; glow discharges; and arc discharges. It is perhaps appropriate that the author, who has worked for many years in the laboratory made famous by Townsend, should include chapters on conduction in feebly ionized gases and on ionization in an electric field. There is a reasonable degree of uniformity in the standard of treatment of the subject; the one exception to this being the chapter on recombination, which with seventeen pages appears comparatively inadequate. On the other hand, Chapter 3, which deals with individual collision processes, is particularly good and achieves a nice combination of clarity with sufficient detail. In this chapter also, the author's skill in explaining the physical basis of the quantum theory of atomic processes is particularly in evidence. It is not by any means always easy to do this in simple terms, and the explanation that electrons in metals are "so strongly bound that only an insignificant number can contribute to the specific heat of the metal" does not perhaps represent the most important feature of the Fermi levels.

In presenting the latest experimental information, the author has included some results which have since been found to be unreliable. On p. 141, for example, the table of values of electron recombination coefficients has one or two doubtful entries, and in the same category is the statement on p. 143 that molecular positive ions of helium are the principal ions in discharges of this gas at ordinary pressures.

However, these are minor points in an excellent book which will appeal particularly to final-year students and to those embarking on research in this subject.

J. SAYERS

BACKGROUND AND PHILOSOPHY OF MODERN PHYSICS

Physics and Microphysics

By Prof. Louis de Broglie. (Translated by Dr. Martin Davidson.) Pp. 286+9 plates. (London: Hutchinson's Scientific and Technical Publications, 1955.) 21*s*. net.

THE late Albert Einstein contributes an all too brief foreword to this book, but he aptly sums up the remarkable series of essays which it contains by referring to it as "a unique book". Louis de Broglie is primarily a theoretical physicist, and it was through his careful and critical analysis, in the early 1920's, of the necessity to reconcile the granular and undulatory aspects of light that he was led to suggest the extension of the idea of the duality of waves and corpuscles to all elements of matter. He predicted the relationship $\lambda = h/p$ between the wave-length λ of the wave associated by wave mechanics with a corpuscle of momentum p, which was very soon afterwards verified experimentally. This same brilliant analysis and exposition de Broglie applies in this volume to the discussion of the formal opposition between the physics of phenomena on the large scale where the classical ideas of localization in space and time, of determinism, and of the individual object, are fully valid, and the physics of the atomic and corpuscular scale where, because of the quantum of action, these ideas are obscured or must be verified.

The original French edition appeared in 1947 and was entitled "Physique et Microphysique". Dr. Martin Davidson, who is to be congratulated on his excellent translation of this important work, has with the consent of the author made some alterations to the original text. Chapter 12, which was entitled "Un Glorieux Moment de la Pensée Scientifique Française", has been omitted completely, and Chapters 9, 13, 14 and 15 have been summarized. Also, since with the rapid progress in atomic physics during recent years some of the statements and data presented in the original French version are now incorrect or require modification, Dr. Davidson has where necessary added suitable explanatory notes at the end of the appropriate chapters. The contents consists of seventeen essays or lectures divided into three parts appropriately headed—science, scientific philosophy and history of the sciences.

In the first part, de Broglie describes the early development of our knowledge of the elementary particles of matter and how progress in this direction has transformed our theoretical conceptions of the constitution of nuclei and of the fields that assure their stability. Other chapters deal with the part played by light in the physical world; wave mechanics and electron diffraction; the concept of quantity in physics; and the formation of images in corpuscular optics.

The opening chapter in the second part, "The Revelations in Microphysics", is worthy of considerable study. Bohr's idea of 'complementarity' is given some emphasis, and the philosophical implications of atomic physics and wave mechanics are outlined. de Broglie is a modest man, but it is necessary for him to look back in retrospect on the origins of wave mechanics; thus, Chapter 8, which is devoted to personal memories on the beginnings of wave mechanics, is excellent reading and shows up clearly the deep insight to physical problems that de Broglie possesses. In later chapters the ideas of Zeno and Bergson on time and motion are considered in relation to the new physical concepts, and with regard to chance and contingency in quantal physics von Neumann's views are discussed in some detail. Finally, in the third part, de Broglie tries to emphasize the link between pure science and its applications; the moral problems introduced by the atomic era; and the grandeur and nobility of pure and disinterested science. He concludes the last chapter, "The Great Adventure", with the words: "In the work of science man has been able to show the force of his intelligence; if he wishes to survive his own successes, it is necessary that he should now show the wisdom of his will".

This is a book that every physicist should read and ponder over.

S. WEINTROUB

THE COLLECTED PAPERS OF H. A. KRAMERS

Collected Scientific Papers

By H. A. Kramers. Pp. xi+969. (Amsterdam: North-Holland Publishing Company, 1956.) 45 Dutch florins; 90*s*.

THE world of physics has good reason to be grateful to the editor of these collected papers, N. G. van Kampen, and to the various Dutch funds and institutions which generously supported the publication of this monumental volume.

A number of Kramers's papers were published in not too accessible journals, but will now be readily available. Among those are his thesis, the paper on the Kramers–Kronig relations, and the papers on his renormalization theory (Como, 1937; Solvay, 1948). Indeed, the fact that modern mass- and charge-normalization procedures were anticipated by Kramers in his radiation theory of 1937 is only too little realized.

The papers are broadly arranged according to subject, and within each group chronologically. The first group contains the papers from Kramers's Copenhagen period on the quantum theory and later papers on quantum mechanics. It includes his paper in the *Philosophical Magazine* on X-ray absorption, the Kramers–Heisenberg paper, and the paper on the *W–K–B* method. It also includes his papers in the *Proceedings of the Amsterdam Academy* on the so-called symbolical method. The second group deals with paramagnetism and ferromagnetism. The last group is a mixed one. It includes his papers on quantum electrodynamics, the Kramers–Wannier paper on order–disorder, and the paper on charge conjugation in the Dirac hole theory.

It is impossible to do justice to this book in a short review. It shows better than any obituary could do the many-sidedness of Kramers's work as a physicist. Unfortunately, it was decided not to include Kramers's philosophical and popular papers. These show his wide understanding of the human aspects of physics. They are practically inaccessible, especially to those without a reading knowledge of Dutch, and a selection of them (in translation) would have been a very valuable addition. (His Leyden inaugural lecture, "Physicists as Stylists", was translated (*Naturwiss.*, **24**, 297; 1935) and rewards the reader with a broad vista of physicists as human beings.)

His semi-popular book on early quantum mechanics, written in collaboration with Helge Holst, has long been available in many languages, and his text-book on the foundations of quantum mechanics is about to be published in an English translation, so that Kramers's complete works will now be readily available, apart from his popular papers.

D. ter Haar

TRENDS IN ANATOMICAL TEACHING

Lehrbuch und Atlas der Anatomie des Menschen
Von Dr. Fr. Kopsch. In zwei bänden. Band 1: Allgemeines, Skeletsystem, Muskelsystem, Gefässystem. Pp. viii + 736. 64.50 D.M. Band 2: Eingeweide, Nervensystem, Sinnesorgane. Pp. viii + 768. 64.50 D.M. Neunzehnte Auflage. (Stuttgart: Georg Thieme Verlag, 1955.)

THESE volumes have an interesting pedigree for the British reader. It was in 1870 that Carl Ernst Emil Hoffman prepared the first German edition of this work, which he based upon the seventh edition of Quain's "Anatomy". The Quain–Hoffman text was then, in 1892, taken in hand and revised by Dr. Rauber. The present editor, Prof. Fr. Kopsch, became responsible for the seventh edition in 1906, and has remained in charge of the work until this, the so-called nineteenth edition, so that he has had ample time in which to impress upon it to the full his own anatomical personality.

Printed on good-quality art paper, the two volumes between them contain more than fifteen hundred pages. The type is clear, the binding is robust, and the format of the volumes as a whole is a pleasing one. The illustrations have been conceived and executed on a generous scale. Many of them occupy an entire page, and they appear to have been drawn with great care, though Figs. 528 and 529, showing the segmental areas of skin innervation, seem to be somewhat at variance with what is generally accepted in Britain.

Vol. 1 begins with a general section (pp. 1–100) and then continues with osteology, arthrology, myology and angiology; Vol. 2 deals with splanchnology, the nervous system and the sense organs. The general section gives an account of the basic properties of the cell, and a description of the different cell types—including an estimate of 8 billion as the total number of cells in the human adult (excluding the blood cells). This section also includes a description of the body as a whole, a brief consideration of body build, various body measurements and an account of anatomical terms. In addition to the general histology contained in this section, the special histology of the various organs, beautifully illustrated, is given throughout the text together with the gross anatomy.

A review of an anatomical text-book is an appropriate occasion for recalling that anatomy is one of the oldest of the scientific disciplines, and that the publication in 1543 of the "De Corporis Humani Fabrica" of Andreas Vesalius was one of the great landmarks in the history of modern science. During the centuries which followed, anatomy has had its ups and downs, periods of stagnation alternating with periods of progress.

Towards the end of the nineteenth century, when the young and vigorous sister science of physiology broke away to enter upon a period of rapid expansion, most anatomists devoted their attention to the study of form, as opposed to function. But even when the study of anatomy was confined almost exclusively to the dead body, the boundary between these two facets of biology was never perfectly clear-cut, and in recent years has become blurred to an increasing extent. There has been an anatomical revival, which has steadily been gaining momentum, based on a variety of new techniques for the study of the living organism and its component tissues. As a result of this development, the fields of anatomical and physiological studies have tended to overlap more and more.

However, not all anatomists have welcomed the newer developments with the same degree of enthusiasm, or thought it necessary to incorporate them into anatomical teaching to quite the same extent. Prof. Kopsch takes care to emphasize in the preface that he is adhering in the main to well-tried morphological methods of presentation, and is concerned with form rather than function. But the changes in form which occur during life can only be studied intelligently against a background of function, and if one is too resolute in the avoidance of functional considerations, one is bound to lose much valuable information in the field of living morphology. Thus, to give but one example, there is no reference in the present work to cholecystography.

Subject to considerations of this nature, and within the author's self-imposed limitations, these volumes constitute an impressive tribute to the deservedly high standing of Prof. Kopsch in the anatomical world.

J. M. Yoffey

Old Fourlegs

The Story of the Coelacanth. By Prof. J. L. B. Smith. Pp. x+260+6 plates. (London and New York: Longmans, Green and Co., Ltd., 1956.) 21*s.* net.

THIS is a popular account of the discovery of the Coelacanth as a living fish. It is also a record of the intellectual agonies suffered by a sensitive man of science when confronted with a phenomenon which made nonsense of his previous academic training and experience. Smith tells not only of the way in which the first fish was brought to his notice and of the way in which he pursued the second but also of his investigations, which showed that this animal was no denizen of the deep, as suggested by many authorities, but lived in the reefs off the remote Comoro archipelago approximately midway between Portuguese East Africa and northern Madagascar.

Among the difficulties which Smith had to overcome before obtaining his second fish was getting permission from Prime Minister Malan to use a military aircraft for a quick and essential journey to Comores, and an excursion into diplomatic channels to persuade the French Governor of the Comores that the fish could belong to no other than Smith despite his South African nationality. Many of Smith's personal difficulties are dramatically described and a number appear to have been of his own devising. Against this, it is almost certain that the writing of yet one more chapter in the story of the natural evolution of animals would not have been made without his fanatical devotion to the Coelacanth. His relentless pursuit after factual evidence is worthy of the true man of science and it is good that Smith has set down a record of his fears and hopes and disappointments and triumphs as encouragement for others. The story is not well told but is so romantic in itself that the telling scarcely matters.

T. H. HAWKINS

Electric Dipole Moments

By Dr. J. W. Smith. Pp. vii+370. (London: Butterworths Scientific Publications, 1955.) 42*s.*

DR. J. W. SMITH has provided a sound, solid and comprehensive account of dipole moments, an important field which has gathered fresh impetus during recent years. The first three chapters of his book deal with the general physical theory, with the conventional method for measuring dipole moments, and with various unconventional methods, mostly recent. The headings of the remaining chapters are: general results; the origin of electric dipole moments; solvent effects; induction and mesomerism; dipole moments in relation to molecular structures and configurations; atom polarization; restricted rotation about single bonds; molecular association and molecular interaction. There is an appendix on wave mechanical principles, and a table of bond refractions.

On the whole, this is a good book: it is well written, well produced, and covers the subject in a very satisfactory manner. One could wish that the author were more critical, particularly in the sections on evaluation of results and on solvent effects: the general reader would find them tedious; the specialist would find them inadequate. The appendix on quantum theory is quite useless, and the space could have been used better in other ways; for example, the experimental section is marred by failure to quote the types of valve used in many of the circuits and the dimensions of the dielectric cells. The general accuracy of the measurements is nowhere properly discussed. The account of carbon monoxide and nitric oxides on pp. 112–4 is very confused.

However, these failings are not serious, and the book can be confidently recommended to all chemists who have any interest whatever in the subject. The price is not unreasonable.

M. J. S. DEWAR

Magnetic Materials in the Electrical Industry

By P. R. Bardell. Pp. 288. (London: Macdonald and Co. (Publishers), Ltd., 1955.) 32*s.* 6*d.* net.

THE intention of the author of this book is to help students of physics and electrical engineering, and also physicists and engineers in industry, to a fuller knowledge of magnetic materials, their properties and their applications. It also sets out to resolve some of the difficulties arising from proprietary names of materials and confusion among technical terms and units. Prof. James Greig, in a foreword, welcomes the book as relating engineering practice to scientific principles and physical phenomena.

The chapters on permanent-magnet and high-permeability materials describe the development of these materials and their ability to meet the requirements of various applications. The characteristics of many materials are presented in tabular form by type and maker's name. There are two chapters on the application of soft magnetic materials at power and communication frequencies; they include the properties of powder cores and ferrites. The effects of flux density and frequency on loss are well brought out, but the effect of saturation on wave-form is not considered. Various methods of measuring soft magnetic materials are described. Magnetic recording is also dealt with clearly and simply. The testing of materials by magnetic means is considered under the headings of magnetic discontinuity and of magnetic characteristic, and examples of each are described.

The principles of magnetic amplifiers and transducers and some typical equipments are described. At the end of each chapter is a list of references; an appendix contains a glossary of terms referred to in the text, and there is an adequate index. The tabulated information of the characteristics of magnetically hard and soft materials is well presented, and there are good illustrations of various items of equipment such as power transformers, telephone relays, choking coils and powder cores.

This book will be found most useful by students and others to whom the properties of many industrial magnetic materials are not readily available.

H. M. C.

Elizabethan Copper

The History of the Company of Mines Royal, 1568–1605. By Prof. M. B. Donald. Pp. vii+405+9 plates. (London: Pergamon Press, Ltd., 1955.) 60*s.* net.

THE history of metalliferous mining in Britain has not, as yet, received the attention it deserves, and it awaits an author who will deal with the subject comprehensively and as a whole. Meantime, an important contribution to the story has been made by Prof. M. B. Donald, who has brought to his task not only a practical interest in historical research, but also the necessary technical background acquired during a career that has embraced both the commercial and academic sides of technology.

This book tells, with much detail, the story of the opening up of copper mines in the Lake District in the sixteenth century, and of the formation of the Company of Mines Royal which was incorporated in 1568 to exploit these mines. In addition, the reader is given an account of the commercial and legal background, together with biographical details of the principal participants in the activities, including the technical advisers who came to Britain from Germany to superintend operations. The tale unfolded discloses that the promotion and exploitation of mines were carried out, in Elizabethan times, in a manner not very dissimilar from that employed to-day. A later chapter in the book describes the opening of copper mines in Cornwall during the same century.

Many manuscript sources, some new and unpublished, have been consulted in compiling this book, which is both an interesting and important contribution to the history of technology. It is likely to remain for a long time to come a standard source book for the field it covers. V. A. Eyles

Chemical Trade Names and Commercial Synonyms

A Dictionary of American Usage. By Williams Haynes. Second edition, revised and enlarged. Pp. vi+466. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 60*s*. net.

THE title of this book indicates its scope reasonably well, but the intention is to limit the terms listed to those of chemicals and chemical preparations sold industrially rather than by retail; pharmaceutical products, either as individual chemicals or compounded, are not included.

A trade name is accompanied by an indication of the American supplier and, ideally, the definition gives first the composition and then the chief uses. There are gaps in definitions that could be filled; for example, Santowax P, described as a "coal-tar resin", is known to be *p*-diphenylbenzene, and the identity of Musk Tibetene has been published (Fuson, 1947). There are also obvious errors; thus methacrolein is stated to be *iso*butylene oxide, heptyl alcohol to be octanol and methionine to be sulphur-free. There is an occasional weird definition as, for example (p. 95), "hydrosulphite product free from heavy *m*-dianisidine", and there are double entries such as for methoxychlor, oxone and durene. There are innumerable printing errors, each petty in itself but aggravating in the aggregate, and there is more than one indication that at least some such errors have arisen from the setting of copy as received.

Much useful information has been collected here for anyone who has contacts, however indirect, with the American chemical market; but, as already indicated, there is plenty of room for improvement in detail. Moreover, does that market deal in acetic acid as "vinegar of Venus", in formic acid as "spirit of ants" and in carbon dioxide as "acid of air"? Maybe it does, since there is apparently still a call for woad. B. A. Ellis

Quantitative Methods of Organic Microanalysis

By Dr. S. J. Clark. Pp. x+253. (London: Butterworths Scientific Publications, 1956.) 30*s*.

ON looking at the library of books on quantitative organic microanalysis, one would not say that there is a surfeit of literature, and so a new volume by a new author immediately arouses interest. By incorporating the latest methods with older proved ones, this book fills a much-needed gap, especially if allowance is made for the speed with which modifications are published in the journals. However, some of the methods are so new, and so much reference is made to "unpublished works", that for the moment they cannot inspire a great deal of confidence in them.

As the author has included both old and new methods in a book of only 250 pages, one gets the impression of a skimping of detail. For example, the use of nickel ammonium sulphate as an absorbent for ammonia is given on p. 93, but no reasons are stated for its choice. On p. 104, one is left guessing as to whether the hydrogen peroxide is neutralized before use, and boiled after absorption to destroy excess, as is done in the standard procedure. The first five chapters deal with the usual routine weighing, general apparatus techniques and ashing. Except for the inclusion of the Karl Fischer water determination, and ion exchange for determination of metals, they remain virtually unchanged. Six chapters are devoted to elementary analysis, and the following five to the determination of functional groups. Of particular interest is the inclusion of fluorine with the halogens, the direct determination of oxygen, and titrations in non-aqueous solvents.

The microanalyst is of necessity an individualist, and although he may not use completely any one particular method, he can obtain from this book much useful information to try out for himself. It is recommended for a place on the bookshelf.

F. H. Oliver

Photographie et Cinématographie Ultra-Rapides

Actes du deuxième Congrès International de Photographie et Cinématographie Ultra-Rapides, Paris, Septembre 1954. Présentés par Pierre Naslin et Jean Vivie. Pp. xxviii+456. (Paris: Dunod, 1956.) n.p.

THIS volume is a record of the second International Congress of High-Speed Photography held in Paris in 1954 and contains more than sixty contributions dealing with many branches of high-speed photography and cinematography and their applications. Each article begins with a summary in each of the three languages of the conference, English, French and German, and is printed in full in one of them.

The value of this volume lies not only in the wide field which is covered but also in the fact that the articles are authoritative, many being contributed by acknowledged experts in this field of photography. In addition to being a source of reference to modern techniques, this book will also be of great use to anyone searching for a method of recording for some new investigation. It is often by taking a technique which has been developed in reference to one particular subject and by adapting it to another that advances are made, and here one can see what methods are being used in fields of investigation which are very remote from each other.

On the whole, the volume is well produced; but a slightly more substantial paper might have resulted in better reproduction of some of the illustrations. The coloured plates, for which special paper has been used, are well produced. The index is not very adequate; but perhaps if a more elaborate one had been attempted the production of the book might have been delayed and this would have been undesirable for, as is well known, the third International Congress is to be held in September of this year in London under the auspices of the Department of Scientific and Industrial Research.

HUMAN PROBLEMS OF INDUSTRIAL COMMUNITIES

H.R.H. The Duke of Edinburgh's Study Conference on the Human Problems of Industrial Communities within the Commonwealth and Empire—to give it its full title—looked at first sight an intellectually unmanageable proposition. The intention was to collect about 280 members, ninety from the United Kingdom and the remainder from overseas, half managers and half trade unionists, for three weeks, of which the first and last period would be in Oxford and the centre ten days spent, in twenty groups, visiting factories and social institutions in twenty principal cities of England, Scotland and Wales. The members were not to be intellectuals or research workers, but men in the early prime of life actively engaged in industry either as managers or worker/trade unionists. The bill of fare for the Conference fell into four stages. First, the circulation, three months in advance, of twenty-five "Background Papers", dealing either with practical problems as seen by a practical man ("Stabilization of Labour in the Rhodesian Copperbelt", by Sir Ronald Prain), or with more general problems seen academically ("The Will to Work", by Prof. C. A. Mace; "Work and Community in a Primitive Society", by Prof. Raymond Firth). Second, a series of ten major addresses in plenary sessions at Oxford, with some very short group-discussion periods to enable the members to meet one another. Third, the "Study Tours", in which the whole Conference dispersed in groups of fourteen members with the addition of a specially selected United Kingdom chairman, each group spending about five days in a provincial city and its neighbourhood and four days in London. Fourth, a period of three days intensive group discussion in Oxford, followed by oral reports from groups and a general summary.

At first sight, the Conference ran with outstanding success. After more than two years of intensive preparation, the members, in almost exactly the planned proportions, and of very high quality, arrived in Oxford on July 8 and were swept through the programme, from the impressive opening ceremony in the Sheldonian to the final dinner in Christ Church on July 27, without a major hitch. All the incidental values (and they are not to be undervalued) were realized: the mixing of nationalities and industrial 'sides', the total absence of colour-consciousness, the sense of fellowship and common search. Nevertheless, it remains to ask three important questions: Was the subject-matter, so handled, manageable? Did the members absorb new ideas to any useful extent? What lasting effects can the Conference hope to have achieved?

Possible criticisms are obvious and formidable. It is acknowledgedly a difficult matter to hold the attention of such differing groups as sugar plantation workers in the Caribbean and Canadian electronic engineers. How could any programme the wit of man could devise suit both? Again, it is supposedly true that education, particularly via discussion groups, does not go very well when the gap in background and intellectual sophistication between the students is too wide—and it is hard to imagine wider gaps than those which existed in this Conference. Finally, the practical experience of the study tours was, of necessity, a rapid survey of certain problems of the United Kingdom, utterly unlike those of Pakistan or Sierra Leone or Johannesburg, and of necessity dimly comprehended and inaccurately interpreted.

Common Problems

These are formidable objections. Yet the conviction of a great number of intelligent members contradicts them flatly. My own answer to this conundrum was found in the recollection that industrialism is, in the full sense, a culture. It is so easy to recognize this about the past—historians and anthropologists speak readily of, say, pastoralism and the complex of religious, social and economic patterns of life associated with it. 'Industrialism', too, means more than certain manufacturing techniques; it has been based on a certain philosophy, it has raised certain political problems, it has set a certain social pattern wherever it has appeared. Examination of some of these associated effects of industrialization may be the best way of explaining why this diverse body of Conference members, from diverse backgrounds, in fact found a common language.

In the first place, the factory itself is a major and new political event. To hold some hundreds of men together, over long periods of time, in co-operation towards a single end, has only been achieved in history—on any wide scale—by three methods: slavery, military discipline or monastic discipline. The factory poses entirely new problems. From whence is the authority of 'the management' derived? What are its sanctions, and its limits? If we are to speak of leadership rather than authority, what are the common purposes between leader and led which can provide the continuing reason for consent? These are common problems "whether on the shores of Asia or in the Edgware Road". Within them lies the problem of personal and group satisfaction at work.

Again, and still in the political field, industrialization involves a shift of power away from old landowning and aristocratic groups; it means a rapid erosion of the influence of hereditary status (birth, chieftainship, caste) and the emergence of a new group of technical, administrative and professional leaders. This is true in Britain, and it is becoming clear in India (Mr. Tata explicitly commented on it in his address), in Africa and in Fiji. It is interesting that the newer societies, such as Australia, never greatly felt this problem, because industrialization has developed in almost pure form with no earlier culture to compete with. Moreover, not only does power shift, but also it tends to become centralized, both in the community and in government, by the growth of industrial combines and by the increasing need for State intervention and planning. This has been seen in Britain in developed form, despite our conscious efforts—not wholly unsuccessful—to retain and bolster local government and local initiative.

This leads directly to a third common effect. The industrial 'exchange economy' leads to a final break with the older subsistence economy based on the land. Once the 'worker' becomes wholly dependent on 'finding work', and has neither land nor tools of

production to fall back upon, he is perilously dependent on the stability of the economy—the maintenance of 'full employment'. Far richer, but far more complex, the man-made industrial economy demands a man-devised fashioning of society—all the insurances against temporary breakdown which we call social security, diversification of industry, indeed every form of planned social control. Hence the growth of a planning and executive central State.

Three more common problems must be mentioned briefly, because all three occupied so much of the discussions in the Conference: the impact on family life, the change in the nature of community life, and the quest for social ideals. In certain ways they are connected. As both the mother and the younger members of the family are sucked into independent wage-earning employment, the authority of the head of the family weakens, the older people, once 'retired', tend to be pushed on one side, and ideals of individual personal development weigh more and more heavily against the institution of family and 'home'. So also the peculiar form of industrial urbanization in the big city swamps the institutions of village social life and is apt to leave a mass of atomized individuals instead of a social structure. Both these changes, so obviously connected with the needs of industry both for concentration and for mobility, raise the question of social ideals: Are the needs of production, the aim of material success, to dominate and exclude age-old values of personal and social life?

The Impact of Industrialization

It was around these common problems that the main addresses to the Conference fell. After the opening address by the Duke of Edinburgh—by common consent a brilliant and obviously personal contribution—with its emphasis on humility and study, and on the aims of a civilization rather than the wealth of an economy, Sir John Maud struck the keynote of the Conference work by his speech on "The Impact of Industrialization". Outstanding in my memory of this memorable address, and in its effect on the Conference, were a series of paradoxes. Industrialization can bring, said Sir John, more freedom and more slavery: more loneliness and more fellowship: more civilization and more barbarism. Which way the balance tilts hangs on the personal philosophy, courage, faith and effort of the myriad individuals within society.

Thereafter came a series of addresses, the titles of which show their drift. "The Varying Pattern of Industry", by Lord Citrine; "The Human Problems of Industry", by Mr. Waring, Mr. J. M. Campbell, Sir Alfred Roberts, Mr. J. Crawford, Colonel Grierson; "Everyday Relations of Industry and the Community Around It", by Sir Harry Pilkington and Dame Florence Hancock; "The Two Partnerships—Man with Man and Man with Nature", by Sir Harold Hartley. In the last period at Oxford the discussions were supplemented by five more addresses in a series of "Overseas Viewpoints": "The New Industrial Communities in West Africa", by Mr. R. K. A. Gardiner (Gold Coast); "The Future Responsibilities of Trade Unions", by Mr. A. E. Monk (Australia) (owing to illness, this paper was circulated in written form); "Industrial Problems in a Multi-racial Society", by Mr. H. F. Oppenheimer (South Africa); "Thoughts on the Industrialization of a Predominantly Rural Society", by Mr. J. R. D. Tata (India); "The Effects of Technical Change", by Mr. W. J. Bennett (Canada).

All these addresses were more than able; but beyond question, if we take the addresses of the Duke of Edinburgh and Sir John Maud as the first high points, Sir Harold Hartley's as the second, then Mr. Gardiner's speech, closely followed by Mr. Oppenheimer, was the third, and in certain respects, the highest. Speaking with the most palpable sincerity and controlled feeling, Mr. Gardiner put forward the thesis for equal respect for the human dignity of the individual of whatever race, religion or colour, as the only real basis upon which the future of the Commonwealth could rest. "The individual ought to feel that certain things cannot happen to him as a person, not because he belongs to a privileged group or race." "We can form a society on a set of rules; but if we intend to form a community—and that is what, to me, a Commonwealth means—that can only be formed on the basis of a common understanding or outlook, a common ethos. Is it going to be possible for us to develop this common outlook, to make it possible for us to continue to set an example to the rest of the world?"

"For *us* to continue . . .". Perhaps these words do not look startling in print; but from the speaker, on the occasion, they moved the whole Conference to an ovation reserved for no other speaker save the Duke of Edinburgh himself. Followed, as they were, by a practical, statesmanlike and liberal speech by Mr. Oppenheimer, tackling the problem of Southern Africa foursquare (and, if it had not been tackled, it would have been an abscess in the Conference), they confirmed finally a sense, already growing, that this Conference was not merely a successful façade but an event in which things of lasting importance were happening as day followed day.

Industry and Social Service

Each group of members, fifteen in number including their chairman, spent ten days 'on tour', seeing representative men and women in industry and social service in a very intensive programme based primarily on discussion, with only enough sight-seeing of factories or schools to give atmosphere and background. In fact, the discussion seems to have been admirably frank and full—several factories referred to it afterwards as more like an inquisition than a visit. Each group was given three subjects for special study, and the final reporting, dealing with these special subjects in groups and consecutively, covered the main field of the whole conference.

What came out of these reports? A remarkable unanimity in five or six directions. Smaller working groups where the supervisor really can supervise personally and the manager can manage; personal relationships and personal trust as a factor transcending all other 'incentives' and 'conditions at work'; independent social activity by the community, not managed by the factory; opposition to the employment of married women with young children; restoration of the central importance of family life; the need for spiritual values. When the oral reports are published, these will be some of the leading themes.

It is true that to many people these are platitudes. But fifteen years ago they were in the mouths, not often of 'practical men' but of the so-called intellectuals, social scientists, psychiatrists and anthropologists. It is of real importance that this is now the talk of practical men from all corners of the

Earth—trade unionists and managers alike. Ideas have moved not only out through society from their intellectual fountainhead, but outwards throughout the Commonwealth; and they are the same ideas, whether in Nigeria or Pakistan.

Writing fresh from the impact of this meeting, which developed an atmosphere of common effort which, in the Duke of Edinburgh's words, you could cut with a knife, I am bound to over-estimate the effects of this event. Yet that it was an event, with its own tiny place in the story of the Commonwealth, I am convinced. The members, when they return to the intrigues, the disappointments, the prejudices and the passion of real life in their countries (conferences are never real life) will carry back with them not only an experience of friendship—and that was abundantly evident—but also a reinforcement of faith and hope. Is anything of more value?

GUY HUNTER

PHYSICS OF GAS FLOW AT VERY HIGH SPEEDS

THE summer discussion meeting of the Physical Society was held in the University of Manchester during July 16–17 under the auspices of the Departments of Applied Mathematics and of the Mechanics of Fluids. The subject was "The Physics of Gas Flow at very High Speeds", that is to say, speeds so high that changes in kinetic energy are comparable with the energy required to produce interesting physical changes such as dissociation, ionization and substantial emission of radiation. The implications for the aerodynamics of man-made projectiles travelling at extreme speeds, and also of meteors, were included in the discussion. The shock tube, the principal research tool in this field, was discussed at length, both as regards design and instrumentation for use with very strong shock waves, and in connexion with the results so far discovered by its use. Prof. S. Devons, vice-president of the Society, presided over the meeting.

As Prof. M. J. Lighthill, of the Department of Mathematics, University of Manchester, said in his introductory remarks, the object of the meeting was to promote studies in a field where two great new scientific disciplines of the twentieth century meet and overlap. These disciplines are, on one hand, chemical kinetics, as grounded theoretically on the study of collision processes and experimentally on spectroscopy as interpreted by the quantum theory of radiative transitions; and on the other hand, fluid dynamics, as it has grown up since the discovery of the basic concepts of the boundary layer and the shock wave during the first decade of this century, using the wind-tunnel as the principal experimental tool. Neither subject had yet reached the dignified status of a science in the nineteenth century, when as Sir Cyril Hinshelwood has observed, chemical reactions were classified mainly into those that go and those that do not go, and when fluid dynamicists were divided into hydraulic engineers who observed things that could not be explained and mathematicians who explained things that could not be observed. In the great, and largely successful, struggles of the past fifty years to reach some sort of systematic understanding in both these two fields, the scientists involved were naturally disinclined to complicate their problems by introducing ideas from quite different disciplines. So until very recently it has been the rule for fluid dynamicists to know almost no physical chemistry, and physical chemists almost no fluid dynamics.

During the past five years, however, a movement has grown up with the object of making new advances by pooling the knowledge that has been acquired in these fields. To this end, fluid dynamicists have set themselves to learn about chemical kinetics and students of chemical kinetics have started to study fluid dynamics. These herculean labours have already begun to make important improvements in our knowledge of combustion processes, and a number of conferences have been held in this field. More recently still, external aerodynamics (that is, the study of flow around projectiles moving through the atmosphere) has reached the stage where this pooling of ideas is necessary. To mention an extreme example, it has been announced in the House of Commons that the Americans propose to shoot at Ascension Island from their missile-testing station in Florida. A simple computation of the elliptic orbit which such a missile would have to follow (after it has left the atmosphere and its rocket motors have burnt out) shows that it would have to re-enter the atmosphere with a speed of at least 6 km./sec. But a speed of half this would already be sufficient to cause considerable chemical changes in the air around a projectile. These changes would involve dissociation of oxygen and nitrogen molecules into free atoms, as well as the formation of nitric oxide. At speeds of 6 km./sec. the dissociation of oxygen near the front of the projectile would be nearly complete, and that of nitrogen well advanced. These changes may be expected to have important effects on the airflow about the body, and hence on the aerodynamic heating which is, of course, what constitutes the main difficulty of flight at these speeds. They constitute the main reason why aerodynamicists have been learning chemistry.

The reason for the converse process is the development of the shock tube, which physical chemists have found increasingly useful for studying fast gas reactions since Kantrowitz advocated its use for this purpose five years ago. Developed originally for studying the fluid dynamics of shock waves under conditions far more flexible than could be obtained in wind-tunnels, it has found additional use as a means of studying how reactions proceed in time after the pressure and the translational temperature of a gas mixture have been instantaneously raised by known amounts. For example, the shock tube has been used in this way to determine the rates of dissociation of iodine, bromine and nitrogen tetroxide. Since the shock tube is so useful both in this kind of work and in studying problems of very-high-speed aerodynamics, two of the five main lectures at this conference were devoted to it.

After giving this introduction Prof. Lighthill then proceeded to read his own lecture on the dynamics of a dissociating gas. He began by outlining the scientific advantages of starting, in such a difficult

subject, by studying, both experimentally and theoretically, the behaviour of a pure diatomic gas capable of dissociation into free atoms. The theory falls naturally into three parts: equilibrium theory; quasi-equilibrium theory of the transport properties, including radiative transfer; and flow theory involving large departures from equilibrium.

The first part includes the fundamental thermodynamics and statistical mechanics of the atom–molecule mixture, and also the theory of the flow outside the boundary layer between a body flying at extreme speeds and the shock wave which travels ahead of it, in cases where equilibrium is reached behind this shock wave in a negligible time. Prof. Lighthill described the Busemann theory of this flow, in which the shock wave is wrapped around the body like a piece of paper around a parcel, and also the recent developments by Freeman and Chester in which second and third approximations to the flow pattern, based on Busemann's approach as a first approximation, have been found, yielding more accurate equations for the shape of the shock wave. He gave also an alternative theory of the flow near the stagnation point on a sphere, in which the only approximation used is the assumption of incompressible flow behind the shock wave. The good agreement between these two theories, based on the neglect of quite different features of the flow, in their region of overlap, gives one increased confidence in both.

Prof. Lighthill discussed briefly the kinetic theory of the diffusive heat transfer (stressing the importance of interdiffusion of atoms and molecules) and its application to the theory of the laminar boundary-layer near the front stagnation point on a bluff body, touched on the physical mechanisms of radiative transfer, and then turned to theories of flow involving large departures from equilibrium. Freeman had calculated the passage to equilibrium behind a uniform plane shock wave, an important feature of this process being the decrease in relaxation-rate as the translational temperature drops. He was now engaged in applying similar methods of calculation to the curved detached shock wave ahead of a projectile.

Mr. H. K. Zienkiewicz, of the Department of Mechanics of Fluids, University of Manchester, then gave a lecture on aerodynamics at extreme speeds. This was based on slides prepared to illustrate detailed flows which he had computed using tables of the composition and thermodynamic properties of air in dissociative equilibrium over a wide range of pressures and temperatures. He discussed plane shock waves and expansions in this way and various flows obtained by combining them, and ended by giving a theory for axisymmetrical flow around a cone. In all cases he made a comparison between the behaviour to be expected of air and that which would be predicted if changes in composition were neglected or if the specific heats remained constant.

The lectures on design and instrumentation of shock tubes were given by members of the High Speed Section of the Aerodynamics Division of the National Physical Laboratory, Teddington. Dr. B. D. Henshall first spoke of the reasons for the popularity of the shock tube as a means for producing flows with high stagnation temperature (of the order of ten or twenty thousand degrees). He described the elementary theory of the shock tube, and its modifications by the effect of the walls, stressing the importance of wall resistance to the turbulent flow in the neighbourhood of the contact surface, with its somewhat surprising effect of decelerating the shock wave but accelerating the contact surface itself. He described the use of hypersonic nozzles at the downstream end of shock tubes to attain very high local Mach numbers at the expense of low Reynolds number, and pointed out that, if these nozzles are to 'start' satisfactorily, an initial back-pressure of a fraction of a micron of mercury is necessary. He described shock tubes using more than one diaphragm, and discussed the factors influencing diaphragm design.

Dr. Henshall then described in detail the proposed 6 in. square shock tube at the National Physical Laboratory, and discussed how different aspects of problems of free flight at extreme speeds can be simulated, using the straight portion of the shock tube or the flow after one or two subsequent expansions. Dr. O. L. Schultz described the timing and triggering devices which will be used in this shock tube, the pressure and temperature gauges which are at present proposed, and the way in which the latter will be used to measure transient heat transfer rate. He also described a method of inferring overall drag by measuring the acceleration of a freely floating model.

In the subsequent discussion Mr. C. H. E. Warren, Royal Aircraft Establishment, Farnborough, described the design of the shock tube under construction there. He was against the use of multiple diaphragms and favoured the straightforward use of hydrogen as a driver, raised to high temperature and pressure by combustion with oxygen. He agreed with Dr. Henshall that valuable work on simulating flight at extreme speeds could be done if the stagnation temperature and Reynolds number were reproduced accurately, even though the Mach number in the experiment was far too low. Inaccuracy of Mach number might be got over by changing the geometry.

Mr. E. M. Dowlen, of the English Electric Co., Ltd., Luton, then described the parallel work going on in his laboratory. He stressed the convenience of using small tubes (for example, of 2 in. diameter), and agreed with workers at Teddington on the advantages of surplus gun-barrels as the material of the high-pressure sections. Later, Dr. R. Hide, of the Atomic Energy Research Establishment, Harwell, described the shock tubes in use there, and the work going on concerning the application of magnetic fields to the highly ionized gas behind a very strong shock wave.

A different aspect of gas flow at very high speeds was discussed in the lecture by Dr. J. G. Davies, of the Jodrell Bank Experimental Station, Manchester University. After a general account of the astronomy of meteors, he described the techniques for observing, visually, photographically and by radio echoes from their ionized trails, the entry of meteors into the atmosphere at speeds between 11 and 72 km./sec. He mentioned the importance of observations of the drift of meteor trails as a source of information on winds in the upper atmosphere.

Dr. Davies pointed out that almost all meteors are less than a centimetre in diameter and evaporate completely (owing to heat transfer by direct collision with atoms and molecules of the atmosphere) at altitudes where the mean free path is large compared with the diameter. He described a theory of this process, from which a theoretical expression for the variation of light intensity with distance along the meteor trail can be determined. In some cases this

theory is inapplicable because fragmentation of the meteor occurs, leading to greatly increased radiation and quicker evaporation. Bodies large enough to enter the denser region of the atmosphere, where they acquire a compressed-air cap ahead of them which largely shields them from the direct blows of atmospheric molecules, are those producing trails much brighter than the brightest stars, and they are observed far too rarely for any systematic knowledge of their aerodynamics to have been found. The larger ones reach the Earth in the form of meteorites, which are mostly of irregular shape, often pitted with deep, roughly spherical holes. Prolonged discussion at the meeting of whether information concerning the aerodynamical experiences of these bodies can be found led to no very helpful conclusions.

The last lecture was by Dr. Wayland Griffith, of the Palmer Physical Laboratory, Princeton University, where much of the pioneering work with shock tubes was done under the direction of Dr. Walker Bleakney. Dr. Griffith has been studying in Britain for the past year. He described fundamental work on the experimental verification of the Rankine–Hugoniot equations for a shock wave passing through various gases, using their known equilibrium thermodynamics. This work shows, for example, that although the transverse vibrations of the carbon dioxide molecule are excited in such experiments with a relaxation time equal to that found from acoustic attenuation work, the longitudinal (valence) vibrations still remained unexcited after a time long compared with this (of the order of milliseconds).

Dr. Griffith discussed experimental determinations in shock tubes, by Davidson, Hornig and others, of dissociation rates, and gave theories, both of the chemical kinetics of dissociation, and of the fluid dynamics of the process which may be postulated to infer the rates from the experimental observations. He then described the work which had been done in Dr. A. R. Kantrowitz's laboratory at Cornell University on ionization produced by strong shock waves in argon. The observed time-delays before equilibrium ionization has suggested improved approaches to the kinetics of the ionization process. The luminosity of the shock front itself, which has sometimes been observed, is the result of impurities. The measurements of conductivity of a gas with high electron density has shown satisfactory agreement with theory.

In his concluding address Prof. Devons remarked on the impressive degree of collaboration between applied mathematicians, physicists, chemists and engineers which seems already to have taken place in this field. He emphasized, however, that an even greater degree of co-operation will be necessary, both if the maximum effectiveness for man-made projectiles travelling at extreme speeds is to be achieved, and if the shock tube is to be fully utilized for uncovering the secrets of high-speed gas reactions.

THE WEIZMANN INSTITUTE OF SCIENCE

TO mark the tenth anniversary of the foundation of the Weizmann Institute of Science, the Board of Governors, together with representatives of supporting groups in Great Britain, the United States, Canada and Switzerland, held a conference in London early in July.

The Weizmann Institute had its origin in the Daniel Sieff Research Institute at Rehovoth, a town about twelve miles south of Tel Aviv. The Sieff Research Institute had been set up in 1934 by Mr. and Mrs. Israel N. Sieff, of London, as a memorial for their youngest son, who had died the year before. Dr. Chaim Weizmann (1874–1952), with whom Mr. and Mrs. Sieff consulted before founding the Institute, assumed its direction and was responsible for its first scientific programme.

In 1944 a group of Dr. Weizmann's friends in the United States launched a project to mark his seventieth birthday and raised five million dollars for the purpose. It was then decided to establish the Weizmann Institute of Science, the Daniel Sieff Research Institute being retained as the parent unit.

The foundation stone for the expanded establishment was laid on June 3, 1946, and the Weizmann Institute was formally inaugurated and began functioning in November 1949. The Institute now covers an area of some ninety acres, with four large buildings in addition to the parent structure, the Sieff Institute, and an Institute of Physics in construction. Compared with the Sieff Institute's original staff of ten scientists and some twenty technical and administrative workers, there are now 130 scientists and more than 350 other personnel.

The recent conference was divided into five sessions. Two of these sessions were under the chairmanship respectively of Sir Francis Simon and Sir Solly Zuckerman, and dealt with the Institute's scientific interests.

The Institute engages primarily in research and has no teaching responsibilities, apart from the affiliation of several of its departmental heads to the Hebrew University in Jerusalem as visiting professors. Its main research interests are in the exact sciences—mathematics, physics, nearly all branches of chemistry, and some branches of biology. The desire has lately been expressed by scientific staff at various levels for the introduction of postgraduate teaching as a means of augmenting Israel's reservoir of trained professional man-power and also as a stimulus to their own work. As a result of a recommendation of a Committee which was set up under the chairmanship of Sir Ben Lockspeiser, the Board of Governors has now decided to provide more opportunities for postgraduate training than were available in the past. This Committee also recommended "that the provision of special courses as a useful service for the country, as, for example, in the fields of radio chemistry, plastics chemistry, electronic computing and numerical analysis, be encouraged within the capacity of the Institute". Some time ago the U.S. Government decided to include support of the Radioisotope School at the Weizmann Institute, for training professional men in the use of isotopes, as part of a series of grants it was making for higher learning and research in Israel.

In addition to the heads of departments of the Institute who came from Israel, the conference was

attended, among others, by Prof. P. M. S. Blackett, London; Prof. E. B. Chain, Rome; Prof. Louis Fieser, Harvard University; Prof. H. A. Krebs, Oxford; Sir Ben Lockspeiser; Prof. David Rittenberg, New York; and Sir Robert Robinson, London. Prof. Saul Adler, of the Hebrew University at Jerusalem, and Prof. S. G. Zondek, of Tel Aviv, attended in their capacities as members of the Institute's Board of Governors.

In addition to the resolution extending postgraduate teaching, the Board of Governors dealt with and decided upon certain administrative reorganization and the consolidation of the financing policy.

When eventually put into effect, the postgraduate teaching curriculum will be of great advantage to Israel, which has still to develop and broaden this aspect of its higher learning.

OBITUARIES

Sir Henry Guy, C.B.E., F.R.S.

Britain has always been rich in engineers whose interests lay in the field of practical construction. It has never been quite so prolific in engineers concerned with engineering science. Although in recent years ill-health put a severe restriction on his activities, the death on July 20 of Sir Henry Guy has removed one from the smaller band of those who took an active and prominent part in the encouragement and organization of engineering research.

His interest was no theoretical interest. It was founded on a wide practical experience as an engineering designer. For more than twenty years he occupied the responsible position of chief mechanical engineer to the Metropolitan-Vickers Electrical Co., Ltd., where, in the quest for ever-increasing thermal efficiency, he designed steam turbines which were not only notable advances in regard to the steam pressures and superheat temperatures that were used, but also in regard to the size of the units. The 100,000-kW. turbo-generator which is now accepted as the standard unit for large power stations had already been designed by Sir Henry Guy and constructed by his Company during the 1930's. When the Soviet Government invited competitive designs for a turbo-generator unit to be used as a basis for the development of power stations in the U.S.S.R., it was his design put forward by Metropolitan-Vickers that won the award and the contracts against world-wide competition.

No one was better able to assess the gaps in our knowledge of engineering science than Sir Harry, as his opinion was fortified by his recollection of those many occasions when faith in his own intuition had to replace the experimental knowledge that was wanting.

When the Advisory Council of the Department of Scientific and Industrial Research, of which Sir Henry Guy was a member at the time, considered during the last year of the Second World War how the pattern of research should be developed in Britain, the need for more research on engineering subjects was specially emphasized. A committee under Sir Henry's chairmanship was set up to consider what practical action should be taken, and it was the recommendation of the Guy Committee that led to the foundation of the Mechanical Engineering Research Laboratory now sited at East Kilbride.

No one better could have been chosen as chairman for this purpose. His wide and detailed knowledge of engineering in its many branches made him visualize the sections into which research on fundamental science could be divided without multiplicity, and his guidance was invaluable. The creation of the Mechanical Engineering Research Laboratory became one of his principal interests in later years, and the fact that the pattern of its organization has not been changed since it started has confirmed the wisdom of his views and outlook.

Sir Henry Guy was naturally chosen as the first chairman of the Mechanical Engineering Research Board, and his kindly and tolerant manner in the chair and the sincerity of his desire to convert those who differed from him, or to be himself converted, helped the new organization to surmount successfully its teething troubles. Even during the period when his health was causing anxiety, nothing gave him greater pleasure than to hear from time to time of its success.

He served as secretary of the Institution of Mechanical Engineers during the period 1942–51.

A. McCance

Mr. C. F. Charter, O.B.E.

Cecil Frederick Charter died in London after a brief illness on January 27. He was then director of Soil and Land-Use Survey in the Gold Coast. That country has lost a good friend, a good organizer and an outstanding scientist.

Charter was educated at the Lowestoft Secondary School and at Trinity Hall, Cambridge. After teaching at the Tientsin Grammar School in North China and at the Antigua Grammar School, Charter accepted an invitation to undertake a study of the soils of Antigua and Barbuda. Charter's report on the soil survey of Antigua and Barbuda published in 1937 was reprinted in 1947; in collaboration with P. E. Turner he published in 1939 observations on soils of sugar estates in Trinidad. During 1933–44 he was local scientific officer of the Antigua Sugar Cane Investigation Committee. In 1940 he visited British Honduras and wrote an illuminating report on the soils, many of which are impoverished by long exposure to heavy rain. Charter described as a maturity sequence the soils formed on non-calcareous alluvium of various ages. The alluvium covers a wide area and carries swamp forest, well-drained broad-leaf forest, conifers or poor savannah. Of these, the last two indicate moderate or severe impoverishment accompanied by development of a heavy, feebly permeable, brightly mottled subsoil.

In 1944 Charter was appointed soil chemist in the Gold Coast Department of Agriculture and worked in the West African Cocoa Research Institute. In 1949 he was promoted chief soil scientist of the Soil Survey Division, Department of Agriculture. In 1951 he was made director of a newly created Department of Soil and Land-Use Survey and was made O.B.E. He paid brief visits to the Belgian Congo, South Africa, Tanganyika and British Guiana in

1948–50, and in 1955 made an extensive study tour of the United States of America under the auspices of the Foreign Operations Administration.

In the Gold Coast, Charter developed a new technique in soil survey, employing methods adapted from those used in ecological surveys. Soil, vegetation and land-use were sampled or recorded at regular intervals along traverse lines and at regular intervals across the grain of the topography. Soils were mapped by topographical associations, but within each of the latter, sample strips a mile long by a quarter mile broad were mapped in complete detail to illustrate the soil, vegetation and land-use patterns occurring. Such work involved the use of large numbers of semi-skilled local assistants, the majority of whom Charter had to train himself.

One important detail of the procedure evolved by Charter was the orderly preservation of samples of soil and rock and the regular comparison of each day's findings with the selected standard samples. He was fortunate in that all his African junior assistants could read and write English; their work, however, was closely checked by those with better education or longer experience. The work was done with accuracy and enthusiasm and was generously supported by the Gold Coast Government, which constructed at Kumasi excellent laboratories and offices for Charter's department. At the time of his death, the department had an establishment of some twenty professional staff and 150 junior technical assistants of varying grades.

At the Cocoa Conference of 1949 Charter described the principal cocoa soils of the Gold Coast and discussed the phenomenon of soil creep occurring there and in Central America and the West Indies. After a visit to Tanganyika in 1950, he came to realize that many tropical soils were not truly sedentary but had developed in 'drift' parent materials. In a paper submitted to the Conference of the Consultative Committee for Tropical Africa on the mechanization of agriculture (Entebbe, 1955), Charter advocated bush fallows for maintenance of fertility in peasant agriculture. In an important paper presented at the Cocoa Conference of 1955 he noted that in the Gold Coast cocoa had failed to survive on acid soils ('oxysols') deficient in divalent bases, but had survived on the less acid and more fertile 'ochrosols'. He stressed the importance of including magnesium in fertilizer trials with cocoa. Charter associated the 'oxysols' with the reddish-yellow latosols of Kellogg and Davol (1949). He noted that the relatively infertile 'oxysols' are formed, where annual rainfalls exceed 70–80 in., from the weathering products of highly siliceous rock (quartzites) or from those of pyritiferous sediments which set free sulphuric acid during decomposition. In fact, appreciable amounts of sulphate in the subsoil of Gold Coast 'oxysols' had been found by the analyses of Charter's colleague, A. S. de Endredy (unpublished observation). A brief statement of Charter's views on the broader aspects of soil classification is given in the Proceedings of the Fifth International Congress of Soil Science (**4**, 497–499). A further account of Charter's views has been prepared for the Sixth International Congress of Soil Science by his colleague, H. Brammer.

Charter was born on December 4, 1905. A son and daughter, children of his first marriage, survive him.

HERBERT GREENE

NEWS and VIEWS

Metallurgy at Leeds : Prof. N. J. Petch

THE Department of Coal, Gas, and Fuel Industries with Metallurgy in the University of Leeds is to be re-organized into the three Departments of Fuel, of Chemical Engineering and of Metallurgy. Collectively they will form the Houldsworth School of Applied Science. Dr. N. J. Petch, at present reader in metallurgy, has been appointed to the new chair of metallurgy created during this re-organization.

After taking a degree in chemistry at Queen Mary College, London, in 1936, Dr. Petch spent a year studying engineering and then read metallurgy at the University of Sheffield, where he took his B.Met. in 1939 and was awarded the Mappin Medal. This varied training was completed by three years as a research assistant in the Crystallographic Department at the Cavendish Laboratory. His researches during this period culminated in papers on the positions of the carbon atoms in cementite, austenite and martensite. Dr. Petch then went to the Royal Aircraft Establishment, where he organized a new section of the Metallurgy Department, dealing with X-ray diffraction problems and routine radiography. He also began to take an interest in the field of fracture in metals, with which his name is now particularly associated. Initially this interest was stimulated by investigations of the mechanism of the hydrogen embrittlement of steels; but during the period 1946–49 which Dr. Petch spent in the Cavendish Laboratory with the team led by Dr. E. Orowan, his interests widened to include many fundamental aspects of fracture. Since 1949, when he was appointed reader in metallurgy in the University of Leeds, Dr. Petch has continued his studies of fracture and has published many important papers in the field. A problem common to all university departments teaching the applied sciences is to maintain an adequate balance in lectures between the rapidly expanding new knowledge and the established classical material. Dr. Petch, who is responsible for the teaching courses in metallurgy, has, during the tenure of the readership, carried out a careful re-organization to maintain the balance.

Geography at Liverpool : Prof. R. W. Steel

MR. R. W. STEEL has been appointed John Rankine professor of geography in the University of Liverpool as from January of next year, a post which has been vacant since the death in 1955 of Prof. W. Smith. Mr. Steel has spent his academic life in Oxford. He was an open exhibitioner of Jesus College, Oxford, and while still an undergraduate won the Royal Geographical Society's Essay Prize in 1936. In 1938, he was Draper's Research Scholar and carried out some research work in Sierra Leone. He made a second expedition to West Africa, jointly with an economist and an anthropologist, during 1945–46, and has recently returned from a further visit to Central Africa and East Africa. He has for many years been lecturer in Colonial geography in the

University of Oxford, and was elected a Fellow of Jesus College in 1954. He is the author of a number of papers dealing with various problems of African geography, and no doubt will be able to maintain his connexion with Africa when he takes up his new post.

University of Poona : New Building for Chemistry

The opening of the new building of the Chemistry Department of the University of Poona by Pandit Jawaharlal Nehru on August 1 marks the first stage in the development of the University in the old Government House at Ganeshkhind, Poona-7. The University has built this department at a cost of Rs. 4 lakhs, and though it is still incomplete, the Government of India has agreed to pay two-thirds of the cost to complete the building by addition of the lecture halls. The Ranade Industrial and Economic Institute has been shifted to one wing of the new building. Through the gift of Rs. 3 lakhs from the Government of India, the laboratory is equipped with up-to-date apparatus and equipment for research and the training of postgraduate students in X-ray diffraction, magnetochemistry, ultrasonics, dielectric work, electrochemistry, absorption and fluorescence spectra, optical dispersion, microchemistry, chromatography, chemistry of sugars and gul, enzymes, and chemical instrumentation. There are well-equipped workshops and ample stores. The Government of India has awarded one national research fellowship of Rs. 400 a month and three senior fellowships of Rs. 200 a month. Six University research fellowships and two Shembekar scholarships have been awarded for Ph.D. students. During the past five years six students in the Department have obtained the degree of Ph.D. and twelve that of M.Sc. by research. Ninety students gained their M.Sc. by examinations in different branches of chemistry. More than fifty research papers have been published both in India and abroad. Five students are carrying out postgraduate research for their D.Sc., twenty-five (including six women) for their Ph.D. and five for M.Sc. (by research). There are at present 104 students in the postgraduate classes, twelve of whom are women.

Belgian Youth Federation for the Study and Protection of Nature

A Belgian Youth Federation for the Study and Protection of Nature, a section of l'Entente Nationale pour la Protection de Nature, has recently been founded in Brussels. This organization, which will receive both material and moral assistance from l'Entente Nationale, will be run entirely by young Belgians between the ages of twelve and twenty-eight. The new Federation is also under the patronage of the International Union for Conservation of Nature and Natural Resources, which, since its foundation in 1948, has had its headquarters in Brussels. The aim of the Federation is to affiliate all youth societies throughout Belgium which share the same objectives, and thus Belgium will be able to send a more fully representative delegation to the camp which is being held in Austria this month when a federation on a larger scale, the International Youth Federation for the Study and Protection of Nature, will be founded under the auspices of the International Union for the Conservation of Nature and Natural Resources. The new international organization is a direct development of the International Youth Camps for the Study and Protection of Nature, to which the Union has each year given its sponsorship and its financial support, sometimes with the aid of Unesco. At present, thirteen European countries are participating.

Commercial Irradiation of Diamonds

The United Kingdom Atomic Energy Authority has decided to accept requests for the irradiation of diamonds for commercial purposes, so far as other demands on the available irradiation facilities permit. In the past, the Authority has only consented to irradiate small quantities of diamonds for fundamental research purposes. Charges for this new service will be fixed by arrangement. The general phenomenon of irradiation-induced colour changes in gems was first discovered more than fifty years ago when effects of this kind due to radiations from naturally radioactive substances were first observed. Radiations from particle-accelerating machines, nuclear reactors and artificial radioactive isotopes may now be used to induce these effects. Diamonds irradiated inside a nuclear reactor are coloured green, and subsequent heat treatment may change the colour to brown ; on the other hand, the action of radiation from particle-accelerating machines may induce a blue or blue-green colour. Diamonds irradiated in a nuclear reactor become temporarily radioactive, but this radioactivity decays to insignificance within a few days. Inquiries should be addressed to the Technical Irradiation Group, Isotope Division, A.E.R.E., Harwell.

Employment of Chemists in Great Britain

An analysis given in the *Journal of the Royal Institute of Chemistry* of the 8,555 entries in the 1954 edition of the Register of the Royal Institute of Chemistry, which were sufficiently complete for the purpose, indicates that the proportion of chemists employed by industrial firms has fallen to 58 per cent compared with 60·3 per cent in 1948. Government departments and nationalized industries, excluding the Department of Scientific and Industrial Research and the research associations, employed 13·8 per cent in 1948 and 13·2 per cent in 1954, the new intake being mainly to the Atomic Energy Authority : the percentage in the nationalized industries has increased from 3·6 in 1952 to 3·9 in 1954, and in the Department of Scientific and Industrial Research and the research associations from 4·6 to 5·1. The percentage engaged as public analysts and in consulting work rose from 3·5 in 1948 to 4·4 in 1952 and is now 3·5. The most notable increase since 1952 is in the percentage of technical college teachers—from 4·2 to 5·8 per cent—but the proportion in universities shows little change, and that in schools continued to decrease and is now 3·5 per cent. Entries for those resident outside Great Britain and Ireland were disregarded.

Oil Consumption in Britain during 1954 and 1955

The Petroleum Information Bureau has published a booklet on the "U.K. Petroleum Industry Statistics relating to Consumption and Refinery Production, 1954 and 1955" (pp. 9 ; from the Bureau, London ; 1956) which shows that in 1955 a record was set up in oil consumption in Britain. The total inland consumption of petroleum products (exclusive of bunkering ships engaged on foreign trade) was 23,237,144 tons compared with 21,044,243 tons in 1954, an

increase of more than 10 per cent. Demand for oil for central heating totalled 847,710 tons and has more than doubled during the past five years. Motor spirit consumed was 6,240,391 tons, 5 per cent above the 1954 figure. The booklet shows that sales of premier-grade petroleum were up by 10 per cent over standard grades, which showed a decline on the previous year. The growing popularity of diesel-engine commercial vehicles is revealed by the fuel consumption of the diesel-engined road vehicle ('Derv'), which increased by 188,000 tons in 1955; despite the much-criticized restrictions on major highway construction in Britain, asphaltic bitumen, so commonly employed in road-surfacing, actually showed a 7 per cent rise in consumption over the previous year.

A Medieval East African Coastal Civilization

THE Rev. Gervase Mathew contributes to the May number of *Man* an interesting article on some early cultures of the East African littoral. To-day the whole region is under the influence of Zanzibar; but during the seventeenth and eighteenth centuries—between the fading away of the power of Portugal and the rise of Zanzibar—there existed a number of town settlements which were nominally Islamic in religion and influenced at least in part by South Arabia. Formerly, they have been classed as medieval Persian settlements; but Mathew is convinced that they represent a series of small autonomous Swahili States, oligarchic in their social structure, and using a currency of beads and rolls of cloth when trading in ivory and slaves. Did some of the Southern Rhodesian gold pass that way? Many of the buildings and their decoration and contents are impressive, and indicate wealth and a high degree of culture. Naturally, the influence of the Portuguese, who with the Spanish occupied the area from 1592 until about 1637, was considerable. But even before their arrival it would seem that there had existed an important series of townships in the region, as these are described in the early Portuguese annals. There were great walled cities and a population both dark (African) and white (Persian?), the latter being the ruling caste. It is to be hoped that the author will some day write a monograph on the subject. But before this can be done, excavation will have to be undertaken at a number of key sites, and in the meanwhile every effort should be made to preserve as far as is possible the monuments which have survived.

Research on the Formation of Hurricanes

THE spring number of *Oceanus*, a magazine published quarterly by the Woods Hole Oceanographic Institution, Massachusetts, for distribution to the associates of the Institution and others interested in oceanography, is devoted to meteorology and includes an article by the director of the Institution, Dr. C. O'D. Iselin, on projected research into the formation of hurricanes. Dr. Iselin describes an ingenious theory, which it is hoped to investigate on voyages in the converted 125-ft. cutter, *Crawford* (see *Nature*, July 28, p. 181). The theory is that the essential precursor of a hurricane is a period of abnormally light winds in a part of the northern half of the trade-wind belt in which sea-surface temperature exceeds 27° C. These light winds mean that so few large sea-salt condensation nuclei would form that less than the usual number of the cumulus clouds would precipitate rain, leading to development of unusually high humidity in the lower atmosphere. It is then supposed that an 'easterly wave' disturbance moves along in the trade winds, stirring up the sea and producing many nuclei and stimulating convection by release of latent heat. The intense convection then produces a whirl in the usual way. Dr. Iselin envisages that, if the theory is true, it might be possible, by maintaining random convection in the early stage, to stop the development of the abnormally high humidity and so prevent hurricanes from forming.

Freshwater Biological Research by a School-boy

THE magazine of the Oundle School Natural History Society contains a useful comparative study by a school-boy, M. J. Fenwick, of the biology of species of *Asellus*, *Eucrangonyx* and *Gammarus*. These show that *Asellus* seems to favour almost any kind of water, but it is most frequently found in deep, almost stagnant water among plant debris; *Gammarus* favours very shallow and fairly swift water, usually with a sandy or shingle bottom; and *Eucrangonyx* favours a deeper, almost stagnant pond or pit, where there is plenty of shelter from bright daylight. Experiments showed that *Asellus* survives in water with a low oxygen concentration; *Eucrangonyx* can survive in water of almost any oxygen concentration; while *Gammarus* only survives in water of a very high oxygen concentration. *Eucrangonyx* appears to be strongly negatively phototropic, and *Gammarus* and *Asellus* are slightly negatively phototropic. Another series of experiments showed that *Asellus* is quite tolerant of any temperature from 0° C. to 30° C. *Eucrangonyx* is not quite so tolerant and only survives in temperatures between about 5° C. and 20° C.; and *Gammarus* is much less tolerant and will only survive in temperatures between about 10° C. and 20° C.—considerably lower than the temperatures tolerated by *Asellus* and *Eucrangonyx*. The observations show that each animal fills its ecological niche, and that the three are very rarely found together.

Recent Investigations of Cocoa

THERE was a time, not so very long ago, when new research information about the botany and horticulture of cocoa (*Theobroma cacao*) was relatively scanty and hard to come by. That time may now be said to have receded into the past. During recent months several full and important reports have appeared, including the Annual Report of the West African Cocoa Research Institute for 1954–55 (Crown Agents, 4 Millbank, London, S.W.1; 5*s*.), a Report on Cacao Research, 1954 (Imperial College of Tropical Agriculture, Trinidad, B.S.I.; also from the London Office, 40 Norfolk Street, W.C.2; 12*s*. 6*d*.), the Proceedings of the West African International Cacao Research Conference, 1953 (Crown Agents; 12*s*. 6*d*.), and the Cocoa Conference, 1955 (The Cocoa, Chocolate and Confectionery Alliance, 11 Green Street, London, W.1). From these several publications a comprehensive impression of the very considerable research effort that is now being devoted to all aspects of this important and valuable tropical crop may be obtained. The subject-matter ranges from such topics as soils and fertilizers and vegetative propagation by novel methods, to breeding and selection, the control of fungal and virus diseases and pests, and the processing of the eventual product, the cocoa bean.

Factors in Cell Division

The importance of nucleic acid in growth and cell division is becoming increasingly recognized. Where division in permanent cells has been induced by the application of auxin, there appears to have been an attendant acceleration of nucleic acid synthesis. A. K. Sharma and A. Mookerjea (*Bull. Bot. Soc. Bengal.*, **8**, 24; April–Oct. 1954; issued Dec. 1955 as Acharya G. C. Bose Centenary Commemoration Volume) have attempted to explore the relationship of nucleic acid to cell division and to overcome the difficulties of the penetration of cells by the large nucleic acid molecule, by growing onion root tips in solutions in which the constituents of nucleic acid, or their allies, were present, singly and in different combinations. Some fifteen different sugars, four bases (uracil, guanine, adenine and thymine) and ammonium phosphate were used in different concentrations and combinations. The results, obtained after periods of treatment of 1–168 hours, are set out in considerable detail. Counts of polyploid prophases and metaphases were taken from each root-tip specimen after appropriate treatment, and various other nuclear abnormalities were recorded. Practically all the sugars had some effect in inducing division in differentiated cells, but lævulose proved the most active in this respect. In general, however, no correlation was established between the nature of the chemical used and the induction of division. The significance of the results obtained is discussed in some detail.

Research Defence Society

While a great deal is known about anti-vivisection societies, not so much is known about the Research Defence Society. This Society was founded in 1908 by Stephen Paget and exists to "make known the facts about experimental research involving the use of animals and the conditions and regulations under which animal experiments are conducted in the United Kingdom; to emphasize the importance of such experiments to the welfare of mankind and animals and the great saving of human and animal life and health and the prevention of suffering already due to them; and to defend research workers in the medical, veterinary and biological sciences against attacks by anti-vivisectionists". The Society is pledged not only to make known the facts of medical research and the part played in it by animal experiments but also to ensure that full use is made of medical discoveries of benefit to mankind and animals. It is therefore producing a series of pamphlets which will emphasize the need for making use of medical knowledge gained. The first of these pamphlets will be entitled "Vaccination against Poliomyelitis"; others will deal with diseases the comparative rarity of which to-day has made people dangerously complacent or the defeat of which is in the nature of a containment rather than a total elimination; diseases like diphtheria, smallpox, tuberculosis, diabetes and many others. With the publication of the pamphlets, the Society's journal, *Conquest*, will no longer appear quarterly but will be produced at least once a year.

The American Academy of Arts and Sciences

The following, among others, have been elected foreign honorary members of the American Academy of Arts and Sciences: Prof. M. J. C. R. Courrier, professor of experimental morphology and endocrinology in the Collège de France, Paris; and Sir Geoffrey Taylor, Yarrow research professor of the Royal Society. The following have been elected officers of the Academy for 1956–57: *President*, J. E. Burchard, dean of the School of Humanities and Social Studies, Massachusetts Institute of Technology; *Vice-President for Class I* (Mathematical and Physical Sciences), J. H. Van Vleck, dean of engineering and applied physics, Harvard University; *Vice-President for Class II* (Biological Sciences), H. Hoagland, director of the Worcester Foundation for Experimental Biology; *Vice-President for Class III* (Social Arts and Sciences), D. F. Edwards, chairman of the Board, Saco-Lowell Shops, Boston; *Vice-President for Class IV* (Humanities), W. F. Twaddell, professor of linguistics, Brown University; *Secretary*, B. H. Billings, vice-president and general manager of Baird Associates, Cambridge, Mass.; *Treasurer*, T. B. Adams, treasurer of the Sheraton Corporation, Boston; and *Librarian and Editor*, W. M. Whitehill, director of the Boston Athenæum.

The Institution of Mining and Metallurgy

Mr. G. Keith Allen, reader in mining in the Royal School of Mines, London, and formerly resident director and chief engineer of the West African Gold Corporation, Ltd., has been elected president of the Institution of Mining and Metallurgy for 1957–58. Mr. Allen, who is a graduate in mining and metallurgy of the University of Melbourne, has spent most of his professional career with mining concerns in various parts of Africa. Mr. B. W. Kerrigan has been appointed secretary of the Institution of Mining and Metallurgy and will take up his duties at the beginning of this September. Since 1953 Mr. Kerrigan has worked in the planning office of the Imperial College of Science and Technology, London, and has been responsible for much of the administration of the extensive scheme for the expansion of the College.

The Society for Applied Bacteriology: Officers

The following have been elected officers and members of committee of the Society for Applied Bacteriology: *President*, Dr. M. Ingram; *Secretary*, G. Sykes (Microbiology Division, Boots Pure Drug Co., Ltd., Nottingham); *Treasurer*, C. S. Miles; *Editors*, Dr. S. E. Jacobs and Dr. L. F. L. Clegg; *Publications Manager*, E. A. Whitlock; *Advertising Manager*, E. J. Mann; *Committee*, Dr. Ella M. Barnes, Dr. C. A. E. Briggs, J. W. Egdell, L. D. Galloway, H. B. Hawley, J. Liston, W. H. Pierce, C. A. Scarlett and Dr. Helen R. B. White.

The Animal Health Trust: Awards

The Animal Health Trust has awarded research training scholarships for 1956/57 to the following: Miss J. A. Bailey, for work on parasites, at the Imperial College of Science and Technology, London; R. S. Anderson, for work at the School of Veterinary Medicine in the University of Glasgow on the problem of metabolic disease in animals and, in particular, the electrolyte/water balance in animal tissues; J. W. Boyd, to study for Part II of the Tripos Examination in Pathology at the University of Cambridge preparatory to undertaking research into metabolic disease of animals; Muhammad Irfan, for research at the Royal Veterinary College, London, on the blood picture of dogs, with particular reference to tumours and leucosis conditions; Miss S. R. Wooldridge, to study problems connected with the effects of radiation upon cells in tissue culture, paying

particular attention to changes concerned with cellular division and multiplication and their late application to cellular pathology. The Trust has also awarded Evans final-year studentships to the following: P. G. H. Mann (Royal Veterinary College, London), K. Brown (Royal (Dick) Veterinary School, Edinburgh), M. Fussell (University of Cambridge), E. C. Pickering (University of Glasgow Veterinary School), J. McC. Howell (University of Liverpool) and P. L. Doherty (Veterinary College of Ireland).

Announcements

THE Smithson Research Fund Committee of the Royal Society and the University of Cambridge has awarded the Smithson Research Fellowship to Dr. Anita I. Bailey, of Newnham College, Cambridge. Dr. Bailey, who is a graduate of the University of Witwatersrand, South Africa, is to carry out an investigation, in the Department of Physical Chemistry, University of Cambridge, on the surface energy of some solid materials and of the variations in this quantity which may occur when physical conditions are varied.

THE twenty-third general meeting of the Society for General Microbiology will be held in the University of Exeter during September 20–22. Sessions for reading original papers will be held on September 20. The proceedings on September 21 will consist of a symposium on "Plankton".

THE Mechanical Engineering Research Laboratory (Department of Scientific and Industrial Research) at East Kilbride, Glasgow, is to hold its first open days during September 20–21. Applications for invitations, stating which day is preferred, should be sent to the Director.

THE British Mycological Society will hold its "Autumn Foray" this year in Sheffield during September 6–12. The meeting will be centred on the University Hall for Women, Endcliffe Vale Road, Sheffield 10, where a workroom is available. Application forms and further information can be obtained from Dr. J. Webster, Botany Department, The University, Sheffield 10.

THE annual conference of the Society of Leather Trades' Chemists will be held in the University of Leeds during September 21–22. During the meeting the seventh Procter Memorial Lecture will be given by Dr. G. W. Kenner (University Chemical Laboratories, Cambridge), his subject being "The Present and Future Scope of Peptide Synthesis". Further information can be obtained from the honorary secretary of the Society, G. H. W. Humphreys, Forestal Central Laboratories, Harpenden, Herts.

AN international colloquium on semiconductors and phosphors will be held in Germany at Garmisch-Partenkirchen during August 28–September 1. The introductory address will be given by Prof. W. Schottky, and some ninety papers will be read. Workers from a number of European countries and from Japan and the United States will be attending. Further information can be obtained from the organizing committee at Arcisstrasse 21, Munich 2.

THE third Lignin Round Table will be held during September 24–26 at the Institute of Paper Chemistry, Appleton, Wisconsin, the subject being "The Biogenesis of Lignin". The meeting is sponsored jointly by the Committee on the Chemistry of Plant Products of the National Research Council and the Fundamental Research Committee of the Technical Association of the Pulp and Paper Industry. Further information can be obtained from Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wisconsin.

AN international conference on the fatigue of metals, organized by the Institution of Mechanical Engineers, will be held in London at the Institution's headquarters during September 10–14. Before the papers an address reviewing present knowledge on fatigue will be given by Dr. H. J. Gough, a past-president and honorary member of the Institution. The papers will cover the following fields: stress effects; effect of temperature and environment; metallurgical aspects; basic studies (mechanism, statistical theories and crack propagation); and the engineering and industrial significance of fatigue. Further information can be obtained from the Institution at 1 Birdcage Walk, Westminster, London, S.W.1.

THE fourth of the national conferences on chemotherapy, organized by the Italian Society of Chemotherapy under the direction of Prof. Emilio Trabucchi (director of Pharmacological Institute, University of Milan), will be held in Rome at Palazzo Congressi all'E.U.R. during September 26–27, the subject being anti-tumoural chemotherapy. Afterwards, there will be a one-day symposium on actinomycin, which is being organized by Prof. S. A. Waksman, of Rutgers University, N.J. Further information can be obtained from the Secretary of the Italian Society of Chemotherapy, Pharmacological Institute, Via Andrea del Sarto 21, University of Milan.

THE Second International Congress of Dietetics will be held in Rome during September 10–14 in the Palazzo dei Congressi dell' Esposizione Universale di Roma. The organization of the Congress is in the hands of the Italian Dietetic Association, which is also arranging an exhibition on food and food service equipment, to be held in conjunction with the Congress. The programme of the Congress is in four main sections: recent findings of nutritional research; methods of education in nutrition; principles and problems of feeding large numbers of people; and problems of training dietitians. All inquiries regarding the exhibition should be addressed to the Rassegna Internazionale di Alimentazione e Dietetica, S.A.I.C.A., via Giacinto Pullino 5, Rome. Further information on the Congress can be obtained from the Associazione Dietetica Italiana, via dei Penitenzieri 13, Rome.

THE Institute of Biology is holding a symposium on "The Biology of Ageing" in the Anatomy Theatre, University College, London, during September 27–28. The papers to be given in the first session deal with ageing in bacteria, higher plants and animals. A second session will be devoted to physiological topics, followed by a series of papers on medical and sociological aspects of ageing in man. The final session will deal with psychological changes, the effects of nutrition and genetic variations in ageing. The symposium will, it is hoped, bring together biologists from differing disciplines to discuss a subject of common interest and will also provide a meeting ground for biologists, medical practitioners and sociologists. Further information can be obtained from the General Secretary, Institute of Biology, 41 Queen's Gate, London, S.W.7.

ERRATUM. In the communication entitled "A Method for following Lipolysis induced by Heparin", by Drs. G. Kubie, V. Felt and D. Reichl in *Nature* of July 28, p. 210, in each of the tables the phrase "*in vitro*" should read "intravenously".

NON-DESTRUCTIVE TESTING OF MATERIALS

THE summer meeting of the Non-Destructive Testing Group of the Institute of Physics was held this year in the University of Bristol during July 11–14, and the programme of the meeting was presented under the title of "Some New Aspects of Non-Destructive Testing". Dr. S. G. Hooker, director and chief engineer of Bristol Aero-Engines, Ltd., was the guest speaker at the introductory session, which was held during the evening of July 11. Dr. Hooker reviewed the many important problems of inspection which confront the aircraft manufacturer, and he showed that, in fulfilling the requirements of modern engineering development, existing inspection techniques are far from adequate. He made a plea for physicists to put every effort into the task of providing scientific information of a kind which will not only enable better use to be made of existing techniques but which will also make possible the development of new, and more suitable, inspection methods. By invitation of the Bristol Aeroplane Co., Ltd., a visit to the production plants of the Company, during the afternoon of July 13, formed a part of the programme of the meeting. Dr. Hooker said that the tour of his Company's works had been so arranged as to give emphasis to inspection procedure, and he hoped that the visit would add stimulus to the work with which the Non-Destructive Testing Group is concerned.

This was the first summer meeting of the Institute of Physics which has been devoted to what the Non-Destructive Testing Group decided to call "new aspects of non-destructive testing". The words "new aspects" were included in the title because, until now, it seems to have been the custom to regard non-destructive testing as concerned only with the detection of defects in engineering materials and components. This, of course, is not the case. The detection of defects forms but a part, albeit an important part, of the field covered by non-destructive testing, and a major aim of the meeting was that of directing the attention of physicists to the fact that the whole of physics is involved, in one way or another, in the scientific background of industrial inspection. If progress in the technology of inspection is to be maintained, considerable attention must be devoted to this background, and the right kind of scientific information must be made available to the technologists who fulfil the very important functions of developing inspection techniques and of putting these techniques into practice.

The interests of the Group are not confined to the application of physics in industry. During the past two years the application of physics in medical diagnosis has formed part of the Group's activities, and an evening discourse on "Physical Problems in Medical Diagnosis" was given, on July 12, by Prof. C. B. Allsopp (Department of Physics, Guy's Hospital Medical School, London). Prof. Allsopp showed, by referring to the work of his own Department, how this important application of the physics of non-destructive testing is put to good use by research workers in medical schools, and he aroused the interest of his audience by demonstrating the fact that an exchange of information between physicists engaged on industrial problems and physicists engaged on medical problems can be of mutual value. This was the first time an evening discourse had been included in the programme of a summer meeting of the Non-Destructive Testing Group, and Prof. Allsopp's lecture made it an outstanding event of the meeting.

In almost all the uses to which materials are put, their mechanical strength and mechanical behaviour are important factors—usually the most important factors—to be considered. Nearly all mechanical tests involve the destruction of the material under examination, so that if the mechanical behaviour of the actual material which goes into service is to be determined with the certainty required nowadays, then, in addition to the mechanical tests which are at present used, there is a need for a system of non-destructive testing which will provide an assessment of mechanical behaviour. The establishment of such a system presents a formidable problem; but present beliefs are that much success can be achieved by studying the influence of variations in the constitution and structure of materials on their mechanical and physical properties. If the changes brought about in these two types of property can be related empirically, then it will be possible to use those physical properties, which can be measured non-destructively, as a basis for the development of tests which will detect non-uniformity in the quality of complete batches of materials and will assess the significance of non-uniformity in terms of mechanical strength and mechanical behaviour.

Both Prof. W. Sucksmith (University of Sheffield) in his paper on magnetic properties and the structure of metals, and Dr. D. E. Thomas (Aluminium Laboratories, Ltd.) in his paper on the relationship between electrical resistivity and the mechanical properties of aluminium alloys, sounded a severe note of caution in this respect. Although magnetic and electromagnetic non-destructive testing instruments are already in use in industry for detecting non-uniformity in the quality of materials and components, Prof. Sucksmith and Dr. Thomas showed that indiscriminate use of any method of testing based on the detection of variations in either magnetic or electrical properties cannot, at this stage in our knowledge, be regarded as constituting a reliable inspection technique.

On the question of the assessment of the mechanical behaviour of materials the detection of fatigue in metals was chosen for discussion, and a complete session of the programme was devoted to it.

Dr. R. H. Hanstock (High Duty Alloys, Ltd.) described the fatigue process in metals and showed that the structural changes responsible for the formation of a fissure are highly localized. Physical properties, such as damping capacity, which provide a measure of the energy dissipated during a stress cycle, are an obvious choice for the detection of the onset of fatigue failure; but Dr. Hanstock produced evidence from his own work which showed that, whereas it is sometimes possible to obtain a rough estimate of the fatigue life of a material from initial values of hysteresis loss, in general, because of the localized nature of fatigue failure, insufficient change occurs in the overall energy dissipated per stress cycle for detection to be possible by existing methods of measurement.

Dr. N. Thompson (University of Bristol), reading a paper on structural changes and energy dissipation

during fatigue, prepared by him and Dr. N. J. Wadsworth, described the work carried out at the H. H. Wills Physical Laboratory in which simultaneous observations were made of the metallographic changes visible on the surface, and of the changes in energy dissipation which take place during the fatiguing of copper, nickel and cadmium. From the results of this work Dr. Thompson showed that there is no direct connexion between the changes in energy dissipation and the progress towards fatigue failure.

The development of non-destructive inspection methods for non-metallic materials presents a difficult but, nevertheless, intensely interesting field of investigation for physicists. As in the case of metals, the promise of improved techniques is most likely to be found from studies made of the effects of structure on physical properties. Dr. P. T. Barrett (Terylene Council, Imperial Chemical Industries, Ltd.) reviewed the work which has been carried out on the development of tests for plastic fibres. In his paper on the testing of fibres and their molecular structure, he described the methods of physical measurement which provide information about the structure of fibres, and he discussed the mechanical properties of fibres in terms of their molecular structure.

It is one of the aims of the Non-Destructive Testing Group to encourage discussion on research investigations which have not necessarily been embarked upon for the purposes of non-destructive testing, but which are likely to produce results of use in the development of new non-destructive testing methods. In this connexion, four papers were presented at the meeting. Three of these described work in progress at the Atomic Energy Research Establishment, Harwell, and the fourth work which has been carried out at the National Physical Laboratory, Teddington.

Dr. L. E. Drain's paper on the principles and applications of nuclear magnetic resonance made an impressive contribution to the aims of the meeting. He enumerated twelve applications to which the measurements involved in his work could be put, and six of these applications were of direct use for the purposes of non-destructive testing. Mr. W. A. Runciman read a paper on optical fluorescence in non-destructive testing, in which he described the phenomenon of optical fluorescence and showed that, in addition to its use for detecting surface defects, it can be applied to problems of chemical and microscopic examination of materials. Mr. S. F. Pugh, in his paper on the effects of penetrating radiations on materials, reviewed present knowledge on radiation damage and indicated how the results of work in progress on this subject are likely to provide information on the structure of materials. Finally, Mr. M. F. Markham (National Physical Laboratory) gave a paper on the measurement of elastic constants by the ultrasonic pulse method. In this Mr. Markham described the propagation of stress pulses in æolotropic media, and the information he provided is not only of value from the point of view of establishing new techniques for the measurement of elastic constants, but also its application to the technology of ultrasonic inspection is of considerable importance.

The attendance at this meeting was one of the largest which the Non-Destructive Testing Group has had at its summer meetings, and it is the hope of the Group that the enthusiasm shown throughout the whole programme by those present is indicative of the fact that in the future there will be ample support given to the Group in its task of disseminating information on the physics of non-destructive testing.

E. G. STANFORD

PLANT BREEDERS' CONFERENCE AT CAMBRIDGE

WHEN the first conference of plant breeders was called by the Agricultural Research Council in 1947, forty workers met at the Plant Breeding Institute, Cambridge, then a research institute of the School of Agriculture, to discuss their common problems and to learn something of the work in progress there. In the intervening years the conference met annually until 1950 and biennially since then, inspecting work and discussing mutual problems; the meetings have been held at the John Innes Horticultural Institution, first at Merton and later at Bayfordbury, at the Welsh and Scottish Plant Breeding Stations, and at the station at Loughgall of the Plant Breeding Division of the Ministry of Agriculture, Northern Ireland. With the seventh meeting held on July 4 and 5 at the Plant Breeding Institute, Cambridge, the initial cycle has been completed. The expansion of effort in plant breeding is indicated by the increase in the number of participants to 105 at this meeting, and by the fact that since the first meeting the four main plant breeding centres in Great Britain have been transferred to new stations to provide facilities adequate for the expansion that has occurred.

During the morning sessions, members of the staff of the Plant Breeding Institute gave short talks, which were followed by informal discussions. The afternoons were divided between tours of the field-plots and glasshouses, designed mainly to provide an indication of the scope of the work, and laboratory demonstrations and informal discussions between specialists to allow them to fill in the details of particular interest.

R. Riley gave an outline of the work on alien chromosome addition with reference to wheat breeding. Here the object has been to introduce new genes for particular desirable characters from primitive related species into wheat. From the results so far obtained in the production of new synthetic amphidiploids, the introduction of complete genotypes appears to bring in too many undesirable characters with the good. The work discussed concerns the addition to hexaploid wheat of single pairs of chromosomes from rye; new plants with the addition to wheat of six of the seven rye chromosomes, both as disomics and as monosomics, were shown, as well as some in which only a part of a rye chromosome had been added. Initially the new forms tend to revert to the euploid condition, but it seems likely that balance may eventually be achieved.

K. F. Thompson discussed sporophytic incompatibility with special reference to the possibility of using a set of clones to produce commercial quantities of double-cross seed of uniform types of marrow stem kale. The interpretation of the data so far accumulated is complicated by the range of partial compatibility shown in some crosses, and by the finding that in other members of the family the degree of compatibility varies, probably with environmental differences.

In a survey of the outlook for herbage breeding, J. L. Fyfe stressed the advantages to the breeder of having clearly defined objectives to aim at in his work; a survey of the distribution and relative importance of the diseases of forage crops would facilitate the planning of the programme. He went on to discuss the general possibilities of new breeding methods based on the system used in the production of hybrid corn as compared with the older methods based on crossing and pedigree selection. Some degree of inbreeding can be of considerable value in any programme of breeding with crops which are normally cross-pollinated, even where the aim is not the exploitation of heterosis but only the production of a good variety. Inbreeding tends to provide new and otherwise inaccessible information about the material being studied; at the same time it may so reduce the genetic variability within the breeding lines that plot-size in trials can be reduced, with a consequent reduction in the cost of the trials. Once obtained, the inbred lines are available for use in strain building in the older systems, or after the newer techniques of the polycross or diallel crosses. In the discussion that followed, Dr. William Davies, director of the Grassland Research Institute, emphasized that the most important aspect of forage yield was not the absolute amount, but its distribution throughout the year—factors such as the influence of one cut upon the next and subsequent harvests must be taken into account. Other speakers mentioned difficulties in seed production; the cost may be materially affected by a character, such as stiffness of straw, having little relevance to the vegetative production of a crop.

Miss J. M. Drayner gave an account of observations on the breeding system and heterosis in field beans. Both selfing and crossing occur in the crop, and a balance is maintained because the hybrids tend to be self-pollinated and the inbreds tend to cross. Marked heterosis can be seen in hybrids between third-generation inbreds. It may be possible to produce high-yielding stocks by utilizing the tendency of inbreds to cross, coupled with the use of male sterility, recently discovered in the breeding material.

G. E. Russell discussed virus strain relationships in connexion with the virus yellows problem in sugar beet. Because there has so far been no indication that any form of immunity or resistance to this disease may exist, the work is at present concentrated on the search for tolerance to the disease. To cover a wide field as rapidly as possible, a severe necrotic strain of the virus is being used for the routine inoculations, because it normally produces distinct and severe symptoms in a few days. Although this strain is a convenient one for use in the screening tests, the proper orientation of the breeding programme must depend on a better knowledge of the distribution and importance of the strains in the field. Dr. A. R. Trim spoke of his work on the nucleic acids of sugar beet, both in relation to genetic problems and in connexion with the problems of virus yellows. The indications are that the virus may be a ribonucleoprotein, but analysis of nucleic acids recovered from beet has not progressed far enough to provide definite evidence for this.

Selection for yield in breeding cereals was discussed by F. G. H. Lupton, who paid particular attention to modifications in the method of pedigree selection and to the improvement of techniques in yield trials. Wheat hybrids from a wide range of parent varieties are now being handled at the Plant Breeding Institute, and to speed up the work selection in the F_2 and F_3 generations is made by eye; but from the F_4 generation onward bulks of families are included in yield trials, with only a small proportion of sub-cultures retained for multiplication. Some of the newer trial lay-outs have given improved precision, but the analysis of others is so tedious that alternative methods of comparison are being tried. Other detailed discussion included questions of plot-size and shape, and the effects of guard rows and their omission.

The problem of choice of parental combinations was mentioned by Lupton and taken a stage further by R. N. H. Whitehouse, who described a first attempt at the analysis of diallel crosses in order to assess the comparative value of four wheat varieties, differing in various characters, as parents for the production of new hybrids. He suggested that plant breeders may find the method of value in dealing with other crops.

H. W. Howard gave an account of his investigation of a potato chimera, similar to the variety Red King, that arose in a stock of the variety King Edward. In breeding behaviour the new potato resembles King Edward, indicating that only the outer layer of the apical meristem is involved in the change. In using Asseyeva's technique of eye removal to stimulate the production of adventitious buds in the lower tissues, some plants with white-skinned tubers were produced, as well as plants with tubers of the King Edward type, white splashed with pink. The mechanism of the 'mutation' for the origin of the white type remains in doubt, particularly because such types are also produced when tubers from a seedling with a splashed tuber are subjected to the Asseyeva technique.

Work demonstrated in the field and laboratory included the breeding of new winter and spring wheats with good field-characters; selection techniques have been improved by the introduction of controlled tests of resistance to rust and eye spot, and by the use of special equipment for small-scale milling and dough testing. In the improvement of barleys, yield, strength of straw, and resistance to mildew are among the desired characters in the field; to aid selection in the laboratory, routine nitrogen determinations are made and a micro-malting test has been introduced. Improvement of hardiness of winter types and resistance to frit fly in spring types are among the main points in the work on oats, where quality is being assessed by laboratory determinations of oil content and husk percentage. In the work on the cytogenetics of the Triticinae, the addition of rye chromosomes to wheat was demonstrated, and a number of synthetic amphidiploids were also shown.

An outline was given of the work on beans and clover, where the main emphasis has been on yield and resistance to pests and diseases. In lucerne the main problems concern breeding techniques and seed production; but here, as with timothy and cocksfoot, there is the important question of achieving a balance in seasonal production in the drier parts of Britain. In marrow stem kale, uniform inbred lines differing in habit were shown; hardiness and quality are being studied in this crop. Work on potatoes has recently been extended to include resistance to eelworm in addition to the work on blight and the study of cooking quality. In sugar beet selection for resistance to bolting and the search for tolerance to virus yellows were shown.

PEST INFESTATION RESEARCH

THE greater part of the report for 1955 on "Pest Infestation Research"* is devoted to the collected summaries of some ninety investigations in progress at the Department of Scientific and Industrial Research Pest Infestation Laboratory at Slough during 1955. Many of these investigations were continued from earlier years, and among those reaching completion last year was the detailed study of the behaviour of the carpet beetle. The complex life-cycle of this insect, which involves the deposition of eggs in birds' nests in the eaves of houses, is described and correlated with the mode of infestation. Other biological problems studied include the elucidation of the life-histories and physical limits of several species of beetles and mites which are important pests of foodstuffs.

Problems associated with the bulk storage of various types of grain formed a prominent part of the Laboratory's work. Field experiments on the use of underground grain-storage pits, originally started in Africa, were continued at Slough. The success of this method was found to be due to the rapid decrease in the oxygen concentration, which led to the death of the infesting insects.

Much of the work of the Insecticide Section is of immediate practical importance, being concerned with such problems as the insect penetration of multi-ply paper sacs, the toxicity of malathion to insects, the control of the cacao moth in warehouses and the assessment of spraying and dusting equipment. A major item in this Section's programme of work was an investigation on the means of controlling insect damage to stored groundnuts in Gambia. The chief damage was caused by the groundnut beetle (*Coryedon fuscus*), which attacks the surface layers in the piles of bulk-stored nuts, where up to 94·5 per cent damage was reported after four months storage. Several experimental trials were initiated and a satisfactory degree of control was achieved using insecticidal dusts. Attempts to protect shelled nuts by using bags of various materials did not prove so successful.

The biochemical work of the Pest Infestation Laboratory was largely concerned with studies on the chemical reactions of insecticides with foodstuffs and with fundamental research into the mode of action of insecticides. A particular example of the latter is the investigation on the effects of DDT on phosphorus metabolism in insects, which is likely to prove a valuable addition to our knowledge of the mechanism of insecticidal poisoning in insects. As the report points out, insect biochemistry remains a relatively unexplored field and much research on the normal insect is required before the biochemical effects of insecticidal action can be properly appreciated. It is gratifying to read, therefore, that a proportion of the biochemical work at Slough falls into this category.

An interesting development announced in the report is the proposal to form a pool of entomologists and chemists. The members of the pool will be attached to the Laboratory at Slough and will be available to visit the Colonial territories to undertake specific investigations as the need for them arises. This policy is of obvious importance to Great Britain in view of the large imports of raw foodstuffs, and it is clearly desirable to be able to control infestation at the source. Colonial liaison is, however, not a recent departure, for it has long been an important part of the work of the Pest Infestation Laboratory. During 1955 several investigations were in progress in various Colonial territories, and a great deal of the work done at Slough was directed towards solving problems of food storage in the Colonies.

J. E. TREHERNE

* Department of Scientific and Industrial Research. Report of the Pest Infestation Research Board with the Report of the Director of Pest Infestation Research for the year 1955. Pp. iv+62+8 plates. (London: H.M. Stationery Office, 1956.) 4s. net.

VISUAL DEMONSTRATION OF ALLELIC DIFFERENCES WITHIN CELL NUCLEI

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THE characteristic patterns of cross-banding on the salivary gland chromosomes of dipteran larvæ have been shown beyond reasonable doubt to reflect the linear genetic differentiation of these chromosomes. Some of the strongest evidence in favour of this view comes from the cytological study of chromosomes which, as a result of genetical experiment, have been supposed to possess gene arrangements differing from a standard sequence by inversion, translocation, duplication or deletion. Some of these structural rearrangements are associated with clear-cut phenotypic effects: of these, the 'Bar' mutants of *Drosophila melanogaster*[1] were the first to be so recognized.

The great majority of *Drosophila* mutants cannot, however, be differentiated from wild-type flies when the salivary gland chromosomes of mutant and wild-type are compared. This is certainly not due to inadequate techniques or insufficiently painstaking studies: often enough the chromosome region in which a particular mutant gene is located has been very precisely known.

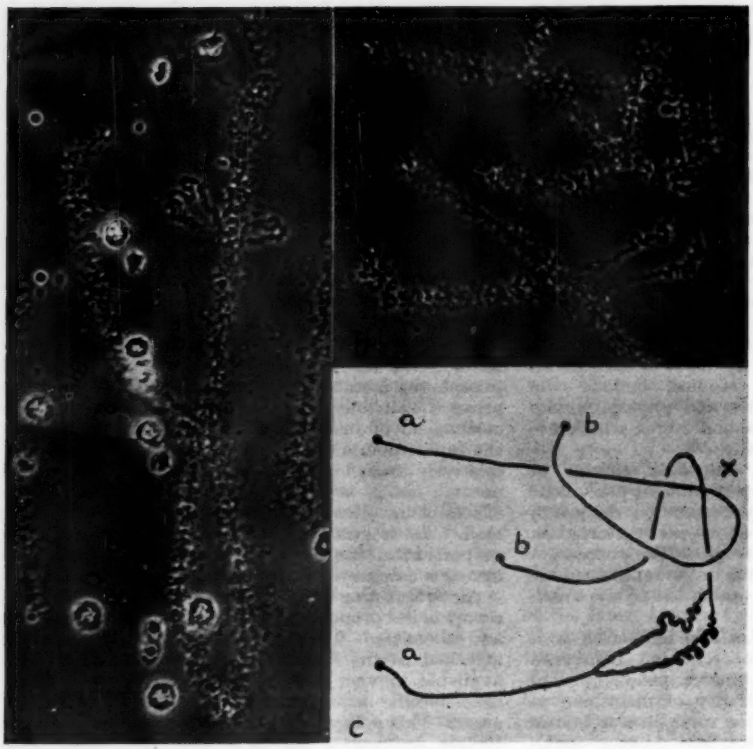

Fig. 1

(*a*) Phase-contrast photograph (× 375) of bivalent X of *T. c. carnifex*, individual *E*. The large loop-pair marked with an arrow on one chromosome is absent from the partner chromosome. The homologous free chromosome arms appear to be of unequal length, but this is merely due to fore-shortening

(*b*) Phase-contrast photograph (× 375) of bivalent X from another oocyte from the same newt. The chromomere from which the large loop-pair originated has suffered breakage transverse to the chromosome axis, in the way very characteristic of lampbrush chromosomes, so that the large loops, marked with an arrow, form a double connecting bridge over the axial break. These large loops are again absent from the partner chromosome

(*c*) Schematic diagram of the bivalent shown in (*b*). Homologous arms are marked *a*, *a*, and *b*, *b*, while the single point of association between homologues is marked *x*

The lampbrush chromosomes of amphibian and other oocyte nuclei also show linear differentiation. This differentiation is most clearly to be seen in the diverse morphologies of the pairs of loops arising from chromomeres in the chromosome axes. There is strong circumstantial evidence that each loop consists of a reflected fibre originating from a chromomere. Around this fibre the primary products of gene activity accumulate (and from which they disperse into the nuclear sap in various forms), the nature and rates of synthesis and of dispersal of the accumulated products determining loop morphology[2]. By studying the distribution of loops of characteristic morphology we have been able to identify each of the twelve bivalent lampbrush chromosomes of the newt *Triturus cristatus carnifex*. We have not attempted to construct comprehensive maps of any of these chromosomes: this would indeed be a very difficult task in view of the varying morphologies of these chromosomes at different stages in the growth of the oocytes. We have instead paid particular attention to the most conspicuous and characteristic loop structures and have so far deliberately concentrated our attention on oocytes of a limited size-range.

In nuclei from oocytes of a given size taken from an individual newt's ovary, homologous chromosomes may be morphologically identical (at least to the extent that we have not noticed differences between them) or they may be clearly non-identical. The non-identity may consist in the presence of a conspicuous pair of loops at a particular locus on one homologue and the absence of comparable loops on the partner chromosome. A typical example of this condition is shown in the accompanying phase-contrast photographs (Fig. 1) of bivalent X (tenth longest, bivalent I being the longest) of *T. c. carnifex*, individual *E*. Inter-homologue differences such as the one illustrated characterize individual newts and are constant from oocyte to oocyte. Individual newts differ from one another in respect of these inter-homologue differences. We have paid careful attention to this matter in five specimens of *T. c. carnifex*, and each of these newts is recognizably distinct. Bivalent I is heteromorphic in all five specimens, though the loci at which it is heteromorphic differ from one individual to another. Bivalent X is heteromorphic in two of the five individuals and bivalent XII is heteromorphic in one. Although the other bivalents appear superficially to be homomorphic, we have little doubt that consistent differences between homologues would also be noticed in these if the cytological study were sufficiently thorough.

The condition described above cannot be due to structural rearrangements of gene sequence by inversion, duplication or translocation such as can be recognized so readily in the salivary gland chromosomes of Diptera: loops of highly characteristic morphology may be found at one chromosome locus in one of two partner chromosomes and nowhere else within the entire complement. Deletions might account for the absence of a particular loop at a given locus; but if this explanation of the phenomenon is to be accepted, four specimens of *T. c. carnifex* must be deletion homozygotes for a locus on bivalent XII which in the fifth specimen regularly bears a pair of conspicuous spherical objects on one homologue, these being equally regularly absent from its partner.

We suggest an alternative explanation: that non-identity of loop pairs at homologous chromosome loci is a direct expression of genetic heterozygosity

at these loci, that is, that different alleles of a given gene may produce loops of differing morphology. As mentioned earlier, differences of loop morphology in all probability depend on differences in the nature or rate of synthesis or of dispersal of the accumulated primary products of gene activity. If this explanation be accepted, then why should allelic differences be visible in lampbrush chromosomes but not in *Drosophila* salivary gland chromosomes? There is evidence, both from studies on salivary gland chromosomes[2] and on lampbrush chromosomes, that genes in a physiologically active state take the form of extended fibres: compact chromomeres which are not spun out into fibres may represent genes in a state of inactivity. The chromomeres of salivary gland chromosomes are for the most part compact, whereas those of lampbrush chromosomes during the active growth phase of oocytes are for the most part extended into the fibre cores of the lateral loops. Thus allelic differences in salivary gland chromosomes are only likely to be detectable if they concern genes which are physiologically active in salivary gland nuclei; for example, loci involved in nucleolus- and Balbiani-ring formation: and Beermann[3,4] has demonstrated what are probably allelic differences at precisely such loci in the salivary gland chromosomes of chironomids. In oocyte nuclei, on the other hand, where the great majority of the genes may be adjudged to be physiologically active, we may reasonably expect allelic differences to be generally discernible. [June 30

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MUTATIONS IN *DROSOPHILA MELANOGASTER* GROWN ON MEDIA CONTAINING CARBON-14-LABELLED SUGARS

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SINCE Muller in 1927 and Stadler in 1928 published their classical studies on the strong mutagenic action of X-rays, high-energy radiation has been the foremost means of inducing mutations experimentally. At first only external irradiation was used; but in recent years the mutagenic action of radioactive materials absorbed by the cells has also been studied. These investigations, reviewed by Muller[1], have dealt with the mutagenic action of radioactive phosphorus and sulphur. Especially interesting is the question whether the transmutation of a radioactive atom located at a strategic point within a gene would result in the mutation of this gene. Although it has been difficult to decide whether the observed mutagenic action was entirely caused by the released beta-radiation or in part also by the transmutation of radioactive atoms located in the chromosomes, certain experiments dealing with the effects of radioactive phosphorus on *Drosophila* have shown that at least under the conditions used the mutations were induced at a rate which could be approximately accounted for by the released beta-radiation alone[2-4]. Thus King found that the radiation from internally located phosphorus-32 atoms was mutagenically effective, but that in the case of male *Drosophila* fed upon phosphorus-32 as adults for 24 hr. there was no indication that internal phosphorus-32 were mutagenically more efficient than external phosphorus-32.

In the experiments to be reported here the mutagenic action of carbon-14 was investigated by rearing *Drosophila melanogaster* individuals from eggs to adults on media containing carbon-14-labelled sugars.

The medium used was a modification of Spencer's[5] medium and was prepared as follows. 2 gm. of powdered agar were added to 320 ml. of water, and the mixture brought to boiling point. 15 ml. of living brewer's yeast were stirred in, and the mixture was boiled for 15 min. 40 ml. of syrup were added. 40 ml. of semolina were thoroughly mixed with 40 ml. of water. This was stirred into the hot medium, and the mixture was brought to boiling point. Then 1·6 gm. of dry 'Bonomold *OM*' (AB Bofors Nobelkrut, Sweden) were added and thoroughly stirred in, after which the medium was boiled for 10 min. Then a small amount of solution containing carbon-14-labelled sugars was added and after thorough mixing the medium was immediately poured into culture bottles, each of which received about 50 ml. of medium.

The carbon-14-labelled sugars were prepared photosynthetically by means of *Canna indica* leaves. Hassid's[6] procedure was mainly followed. After photosynthesis the leaves were extracted with 80 per cent ethanol, the extract was concentrated on the steam-bath, and water was added. Lipids, pigments, and other materials were removed by treating the aqueous residue with ether in a Kutscher–Steudel extraction apparatus. A small quantity of glucose was added as carrier to the aqueous solution, which then was evaporated to dryness under vacuum.

The radioactive sugars were added to the culture media at two levels of activity, namely, approximately 1 millicurie and 0·1 millicurie per culture bottle.

The culture bottles were kept in an incubator at 23–24° C. Cultures with the same medium from which radioactive sugars had been omitted served as controls. Three *Drosophila melanogaster* pairs were introduced into each culture bottle. They were of the young wild-type individuals of Oregon-*K* stock. The new generation developed in fifteen days.

The males grown from eggs to adults on the media containing radioactive sugars as well as the control males were tested for the presence of the *X*-chromosome lethals by means of the Muller-5 technique (cf. Demerec[7]). In the experiments, F_1 females from the crosses between one Muller-5 female and one treated male (these F_1 females were offspring of several treated males) were individually mated, each with one Muller-5 male. The presence of the *X*-chromosome lethals was determined according to the criteria presented by Demerec[7].

The results are shown in Table 1.

Table 1. The Presence of *X*-chromosome Lethals in the First Generation Reared on the Media containing Carbon-14-labelled Sugars

^{14}C activity of medium per culture bottle	F_1 females tested	F_1 females with offspring	Free from *X*-lethals	*X*-lethals No.	*X*-lethals per cent
1 mc.	202	180	175	5	2·8
0·1 mc.	152	139	138	1	0·72
None	90	82	82	0	0

The experiment was continued by placing the flies reared from eggs to adults on the media containing carbon-14-labelled sugars into new culture bottles containing the same media, either radioactive media of two different levels of activity or a non-radioactive control medium. Three pairs of flies were introduced into each bottle. Their male offspring, which thus represented the second successive generation reared on the carbon-14-labelled media, were tested for the presence of the *X*-chromosome lethals.

The results are shown in Table 2.

Table 2. The Presence of *X*-chromosome Lethals in the Second Generation Reared on the Media containing Carbon-14-labelled Sugars

^{14}C activity of medium per culture bottle	F_1 females tested	F_1 females with offspring	Free from *X*-lethals	*X*-lethals No.	*X*-lethals per cent
1 mc.	209	183	179	4	2·2
0·1 mc.	163	149	148	1	0·67
None	80	69	69	0	0

To assess the activity of the media and of the flies, samples of both were taken at the end of the experiments. These samples were dried and oxidized with the Van Slyke–Folch[8] mixture. The liberated carbon dioxide was absorbed into barium hydroxide solution and the barium carbonate precipitate formed was collected on a filter paper disk. After drying, its activity was measured by means of a thin end-window Geiger–Müller counter. The counts were converted into absolute counts by comparing them with counts obtained from a calibrated barium carbonate standard (from Tracerlab, Boston, Mass.) under the same counting conditions. The results of the activity determinations are shown in Table 3.

Table 3. The Activity of the Media containing Carbon-14-labelled Sugars and of the Flies reared on these Media

	Specific activity (absolute) per mgm. of carbon disintegrations/sec.	microcuries
First generation		
0·1-millicurie medium		
Medium	909	0·0246
Flies	971	0·0262
1-millicurie medium		
Medium	9,628	0·260
Flies	9,601	0·259
Second generation		
0·1-millicurie medium		
Medium	893	0·0241
Flies	904	0·0244
1-millicurie medium		
Medium	9,801	0·265
Flies	10,081	0·272

For the purpose of computing the radiation dose received by the flies during their development from eggs to adults under those experimental conditions, we note that the average activities of the media were 0·263 and 0·0244 microcuries per mgm. of carbon, respectively. Since it was calculated that the media contained 73 mgm. of carbon per gm., the activities of the media were 19·2 and 1·78 microcuries per gm. Taking 0·05 MeV. as the value for the mean energy of the carbon-14 beta-particle, we find that the amounts of energy liberated in these media were 4,920 and 456 ergs per gm. in 24 hr., which would be equivalent to 53 and 4·9 r. in 24 hr., respectively. Thus, if the carbon concentrations in the flies were the same as that of the medium, the flies during their 15-day period of development had received a total radiation dose of about 800 r. on the '1-millicurie medium' and of about 75 r. on the '0·1-millicurie medium'. Actually, the carbon concentration must have been somewhat higher in the flies and, consequently, the radiation dose also larger, perhaps by some 50 per cent.

The frequencies of the *X*-chromosome lethal mutations were very similar in both series of experiments. The numbers of mutations observed in flies reared on the '0·1-millicurie medium' are not significantly different from zero. On the other hand, the numbers of mutations on the '1-millicurie medium' are statistically significant if the results of both experiments are pooled ($\chi^2 = 3{\cdot}83$, degrees of freedom 1, $P = 0{\cdot}05$). Thus we feel justified in concluding that the incorporation of radioactive carbon-14 into the medium and through it also into the flies increases the frequency of mutations.

As described above, the total radiation dose which the flies received during their 15-day period of development on the '1-millicurie medium', was about 800 r. The frequency of the *X*-chromosome lethals observed in our experiments, 2·2–2·8 per cent, is approximately the same as those found by several investigators after a dose of 1,000 r.[9–13]. In most of these experiments little attention has been paid to the age of the irradiated flies, which has been shown to influence considerably the number of mutations[13,14]. This remark also applies to our own experiments, in which, however, the *Drosophila* flies received irradiation at the same dosage during their whole period of development. The above comparison indicates that the increase in the number of mutations observed in our experiments can be accounted for, at least mainly, by the mutagenic action of released beta-radiation. This comparison, however, cannot be perhaps considered quite exact, since the irradiation in our experiment, in contrast to all the above-mentioned studies, was distributed over the whole period of development.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Biochemical Evolution : Position of the Tunicates

THE biochemical differentiation[1] between the vertebrates and the invertebrates rested upon the finding that phosphocreatine and phosphoarginine were characteristic of these two classes respectively. Recently, the discovery of phosphagens other than phosphoarginine in invertebrates has suggested some modification of this generalization ; but there are no reports in the literature suggesting the presence of a phosphagen other than phosphocreatine in the vertebrates.

The work[2,3] on members of the intermediate group of protochordates, which indicated the presence of phosphoarginine in the atrial muscle of tunicates, created an anomalous situation, inasmuch as the tunicates appeared to reverse the general chordate pattern[4] biochemically characterized by the presence of phosphocreatine.

In connexion with investigations on creatine phosphokinase[5] and arginine phosphokinase (unpublished results), the opportunity occurred to examine two tunicates, *Pyura* sp. and *Pyura stolonifera* (Heller), for the presence of arginine phosphokinase and phosphoarginine. The atrial muscles were removed immediately after collection (from the south coast of New South Wales) and frozen in liquid nitrogen to prevent decomposition of the phosphagen. A portion of this frozen material was extracted in the cold with trichloroacetic acid (10 per cent) and the extracts neutralized after filtration. A water-soluble ethanol-insoluble fraction of barium salts was obtained which contained a phosphorus compound unstable in 0·1 *N* hydrochloric acid at 60°. The compound was identified as phosphocreatine by ascending paper chromatography in a number of solvent systems. The compound, moreover, did not react with adenosine diphosphate in the presence of arginine phosphokinase isolated from crayfish muscle, but did react with it in the presence of creatine phosphokinase from rabbit muscle.

Another portion of the muscle was extracted with boiling water, and from the filtered extracts, after treatment with ion-exchange resins, a picrate was obtained which possessed a melting point identical with creatine picrate. Chromatography of the initial extract in six solvent systems revealed only one spot reacting with α-naphthol and diacetyl and corresponding in position with authentic creatine. This spot did not give a Sakaguchi reaction, nor did it react with ninhydrin. The guanidine was phosphorylated by creatine phosphokinase but not by arginine phosphokinase.

A third portion of the frozen muscle was finely ground and extracted with 1·5 vol. of water in the cold room for 18 hr. After centrifugation, the extract was treated with ammonium sulphate and a protein fraction obtained which showed creatine phosphokinase activity. No trace of arginine phosphokinase activity was detected in either the crude or partially purified extracts. The enzyme was active not only with authentic phosphocreatine and creatine as substrates, but also with the free base and its phosphorylated derivative isolated from the muscle.

The generalization of Needham *et al.*[3] (that the tunicates contain phosphoarginine) is based on equivocal chemical evidence gained from an investigation of one species but has been generally accepted[4,6]. The present results indicate the absence of arginine, phosphoarginine and arginine phosphokinase in the tunicates as represented by two species. On the other hand, they prove conclusively the presence of creatine, phosphocreatine and an enzyme possessing creatine phosphokinase activity.

Though it is perhaps not permissible to conclude that the tunicates as a class possess creatine, etc., the present work is consistent with, and provides biochemical support for, the accepted phylogenetic classification of the tunicates and therefore removes the anomaly referred to by Wald[4].

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Effect of X-Rays on the Metabolism of Cell Nuclei of Non-dividing Tissues

ADULT mice were given single intraperitoneal injections of either a solution containing ^{35}S-DL-methionine or [8-^{14}C]-adenine. Some of the animals were given whole-body irradiation immediately before injection. The animals were killed at various times after injection, and organs fixed for 1 hr. in acetic acid–alcohol (1 : 3) followed by formol saline ; autoradiographs were prepared by the stripping film technique. The methods employed have been described previously[1].

After injection of labelled methionine some tissues with extremely low mitotic indexes, such as thyroid, seminal vesicle, tracheal epithelium, nerve cells and epididymis, give nuclear autoradiographs suggesting protein metabolism. Although nucleus and cytoplasm are labelled, the resolving power of the method is undoubtedly sufficient to localize sulphur-35 in parts of the cells. Only some of the nuclei are positive in those tissues, the proportion varying within wide limits.

The effect of X-rays on nuclear protein metabolism in the columnar epithelium in the trachea 4 hr. after irradiation and injection is shown in Figs. 1 and 2 ; numerical values are given in Table 1. Weakly positive nuclei were scored as negative, since the photographic grains above them might have been due to sulphur-35 in adjacent cytoplasm. The strength of the autoradiograph above the cytoplasm of the epithelial cells in the trachea is not markedly affected by the irradiation (cf. Figs. 1 and 2). It is about equal to that in positive nuclei in animals killed four hours after injection. Two hours after injection the concentration of sulphur-35 is higher in the cytoplasm of all cells than in positive nuclei. Fewer

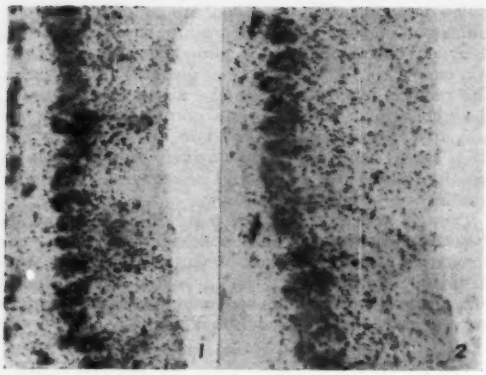

Fig. 1. Stripping-film autoradiograph of the tracheal epithelium of a mouse 4 hr. after injection of ^{35}S-DL-methionine. No irradiation. Hæmatoxylin and eosin stain after photographic processing

Fig. 2. As Fig. 1, but 1,000 r. X-rays before injection

positive nuclei are observed 16 and 24 hr. after injection, but marked accumulations of sulphur-35 are noticeable in the cytoplasm surrounding the nuclei. The secretion is labelled. Table 2 summarizes the changes in the strength of autoradiograph.

No cells in division were seen in the tracheal epithelium in sections stained by the Feulgen reaction, whereas a number of mitoses was observed in the strongly labelled squamous epithelium of the œsophagus of unirradiated animals; mitosis, therefore, is not influenced by the injected radioactive material. It can be concluded that neither the observed nuclear uptake of labelled methionine nor the effect of X-rays on this incorporation is connected with mitosis.

Twenty-four to seventy-two hours after injection of [8-^{14}C]-adenine, a nuclear autoradiograph indicating nucleic acid metabolism was observed in the seminal vesicle and tracheal epithelium in slides treated with ribonuclease before applying the film. Staining with methyl-green pyronine shows that the ribonuclease had hydrolysed the ribose nucleic acid in the nuclei in the preparation.

The connexion between amounts of the nucleic acids and protein metabolism was first pointed out by Brachet[2] and Caspersson[3]. Recently, Gale[4] and Mirsky[5] have shown that the incorporation of amino-acids into cell suspensions derived from dividing cells depends on the presence of intact nucleic acid.

Preliminary results on other tissues show significant differences in the incorporation of methionine as well as the connexion indicated with nucleic acid metabolism as shown by incorporation of [8-^{14}C]-adenine, and the findings reported here cannot be taken to be of general validity for all tissues showing signs of nuclear protein metabolism. It is more likely, judging from preliminary observations, that the various differentiated tissues show combinations of nucleic acid and protein metabolism peculiar to themselves.

Table 1. Effect of X-Rays on Nuclear Protein Metabolism in the Tracheal Epithelium

Dose (r.)	No. of animals	Percentage positive nuclei	
		Single animals	Mean
0	4	77, 66, 69, 55	67
200	1	31	31
1,000	3	20, 17, 24	20

The percentages are based on counts of 300–400 cells per animal.

Table 2. Changes in the Strength of Autoradiograph in the Tracheal Epithelium after Injection of ^{35}S-DL-Methionine

Time after injection of methionine	Cytoplasm	Perinuclear	Positive nuclei	Secretion
2 hr.	++	−	+	+
4 hr.	++	−	++	+
16 hr.	++	+++	++→+++	++
1 day	++	+++	++→+++	++
2 days	+	++→+++	+	+
8 days	+	+	+*	+

−, Negative; +, ++, +++, strength of autoradiograph as estimated. These values are not based on grain counts.
* Very few positive nuclei.

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Mutagenic Effect of Thermal Neutrons on Wet and Dry Tomato Seed

Seeds of two different lots (line 208 and line 215) of the same autodiploid *L. pimpinellifolium* were exposed to thermal neutrons in the reactor at Brookhaven National Laboratory in February 1955. Part of the seed was exposed dry (about 8 per cent moisture) and another part exposed wet (soaked 24 hr. at 25° C. and then sealed in plastic bags at 3° C. for irradiation). Wet seeds were saturated with water and, except for the 24-hr. soaking period and the period of irradiation exposure, were kept at 3° C. until dry again.

In treating line 208, three different wet pretreatments were used: 0·2 per cent colchicine, 0·2 per cent paradichlorobenzene, and distilled water. However, most of the results were homogeneous among the three pretreatments so they have been grouped and reported together as a single wet treatment. One item, mean days to germinate, did vary among the wet pretreatments, seed treated with paradichlorobenzene requiring about 1·5 days longer to germinate.

The principal results from the line 208 experiment are given in Table 1. Germination, survival and sterility data are comparable for both wet and dry seeds, except for the slower germination of wet-treated seeds, which is entirely due to the delay, noted above, associated with the paradichlorobenzene subtreatment.

Mutation data were taken by selfing R_1 plants and observing 36–72 seedling progeny from each R_1 plant for lethal and visible mutations. Lethals were expressed as a 25 per cent reduction in germination and visibles as 25 per cent of the progeny. Visibles were classified as 'chlorotic lethals', 'morphological lethals', 'chlorotics' and 'morphologicals'. The results, given in the last column of Table 1, indicate a much higher

Table 1. Effect of Thermal Neutrons on Wet and Dry Pretreated Tomato Seed, Line 208

Pretreatment	Thermal neutron dose (10^{12}/cm.^{2})	No. planted	Per cent germ.	Mean days to germ.	Per cent survival	Per cent plants sterile	No. tested for mutation	Per cent having seedling mutation
Dry	0	84	99	7·18	100	0	10	10·0
	3·30	84	96	7·50	100	5	26	65·4
	7·05	84	94	8·41	99	38	26	38·5
	11·00	84	77	9·38	80	99	1	100·0
	14·80	84	39	10·36	6	100		
Wet	0	252	97	8·66	100	0	56	0·0
	3·30	252	99	8·75	100	10	73	19·2
	7·05	252	90	9·86	99	37	55	27·3
	11·00	252	87	9·51	73	50	3	33·3
	14·80	252	69	10·39	6	100		

Table 2. Effect of Thermal Neutrons on Wet and Dry Pretreated Tomato Seed, Line 215

Pretreatment	Thermal neutron dose (10^{12}/cm.^{2})	No. planted	Per cent germ.	Mean days to germ.	Per cent survival	Per cent plants sterile	No. tested for mutation	Per cent having seedling mutation
Control Wet and dry	0	648	97	5·77	100	0	51	0·0
Dry	11·00	72	93	7·24	100	72	18	38·9
Wet	11·00	576	76	7·40	87	58	75	54·7

mutation-rate for dry-treated seed than for wet-treated seed, although these differences are in no way indicated in the foregoing germination, survival and sterility data from R_1 plants.

Line 215, which is genetically identical to line 208, was used in a different experiment performed at the same time but involving a different series of wet treatments and only one irradiation exposure of $11{\cdot}00 \times 10^{12}$ thermal neutrons/cm.^{2}. Wet treatments included water and equimolar solutions of the iron, calcium and potassium chlorides, nitrates and sulphates. Since some of these salts produced response differences, the 'wet' results given in Table 2 are summations from only those treatments that were not dissimilar from distilled water.

It is evident in these results (Table 2) that tomato seeds will withstand extremely high doses of thermal neutrons. Barley seed, which is roughly typical of most other seed in this respect, fails to produce plants[1] after about $1{\cdot}9 \times 10^{12}$ thermal neutrons/cm.^{2}. Line 215 tomato seed, however, produces functional plants, almost half of which are fertile, after an exposure that is five times greater than the lethal dose for barley. Furthermore, mutation-rate, which in barley at the top dose[1] of $1{\cdot}4 \times 10^{12}$ is about 13 per cent, is about 55 per cent in line 215 at dose $11{\cdot}0 \times 10^{12}$. This strongly suggests that the functional resistance enjoyed by tomato seeds is cytoplasmic in origin and that genetic damage increases as an approximately linear function of dose in spite of somatic protection.

The difference in sensitivity of two lots of genetically identical seed (lines 208 and 215), which is shown by comparison of the $11{\cdot}00 \times 10^{12}$/cm.^{2} treatments in Tables 1 and 2, is characteristic of tomato results, sensitivity differences depending mostly on non-genetic factors.

With regard to the effect of hydration on response to thermal neutron irradiation, the results from wet and dry treatments show a striking similarity. Wet- and dry-treated seeds (Tables 1 and 2) germinate about as well and about as rapidly, and the plants survive about as well. However, there is a suggestion in both sets of results that plants from wet-treated seeds at high doses are less likely to be sterile and, at lower doses (Table 1), are less likely to have a recessive seedling mutation. Whether this amounts to a real genetic protection by hydration remains to be determined; but, at least, it seems evident that hydration does not increase either somatic or genetic sensitivity of these seeds. Ehrenberg *et al.*[2] have X-ray data, somewhat comparable to these, for mutagenic sensitivity of pre-soaked and dormant barley seed. They show that, at low doses, water increases the genetic effect but, at higher doses (about 15,000 r.), mutation-rate in presoaked seed is "often lower than in dormant seeds". Our results from thermal neutron irradiations at much higher levels than those of Ehrenberg indicate that the genetic protection by water, which began to appear at his high doses, may actually exist. Such protection, however, cannot yet be construed to indicate genetic protection on a cellular level, because the relationship between mutations induced and mutations recovered is still not established in plants.

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Adsorption of Red-Cell Components by Siliceous Earths

In a recent paper by Lovelock[1], the hæmolysis of suspensions of washed human red cells by alumina has been described. The conclusion is drawn from this work that alumina adsorbs dissolved lipids, derived from the erythrocyte membrane, thus hastening the process whereby lipids pass from the cell membrane into (aqueous) solution, leading to the breakdown of the cell.

Prior to my knowledge of this work, I had investigated an accidentally observed phenomenon, the hæmolysis of human red cells by suspensions of a diatomaceous-earth filter-aid, 'Hyflo Super-Cel'[2], used

in chromatography. It was possible to show the adsorption of quite large amounts of lipid material on to the powder after mixing with red cells for a few minutes. Extraction of the recovered powder was performed with chloroform/methyl alcohol mixtures, and the extracts analysed for cholesterol, phospholipid and nitrogen. Control experiments in which the powder was shaken with 0·15 *M* sodium chloride solution used for washing the cells prior to treatment yielded negligible values for the various substances. In two experiments of the type described, alumina was used for comparison.

In addition, some of the lipid material, after extraction from the powder, was freed from cholesterol and dissolved in a mixture of 10 per cent *iso*-propyl alcohol in benzene. Small quantities of this were used for making spread-films on water; the ability of suspensions of 'Hyflo Super-Cel' to lower the surface pressure of these films was measured with a Langmuir film balance. It was found that, while simply introducing a suspension of the powder into the water below the powder had no effect, directing a stream of the particles upwards towards the underside of the film lowered the surface pressure rapidly and considerably.

The results of this work suggest that, at any rate in the case of the siliceous material used, hæmolysis results from an interaction between the cell surface and the powder particle, with direct adsorption of components of the membrane. Particle-size appears to be an important factor in this process.

Details of this work have been submitted for publication elsewhere, and further quantitative investigations of the factors controlling interaction between cell surfaces and solid adsorbents is proceeding.

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Induced Change from Culture Form to Blood-stream Form in *Trypanosoma mega*

In its vertebrate host, a trypanosome multiplies in the trypanosoma form while, in its invertebrate host, it first takes the crithidial form, which is no longer infective, to reappear as metacyclic forms at the end of its cycle. Similarly, in culture, the blood-stream trypanosomes lose their infective power and their typical shape and become transformed into the crithidial form.

We have tried to elucidate the factors responsible for those transformations and succeeded in inducing the development from culture to blood-stream form, by addition of vertebrate serum. We used *Trypanosoma mega*, a parasite of amphibians. This trypanosome has been kept through fifty subcultures in a serum-free medium[1].

Slide cultures were made with various media, examined under a phase-contrast microscope and as stained smears. In young, actively growing cultures, the flagellates multiply as round bodies, often clustering into regular-shaped rosettes. After a few days the rosettes disintegrate, and the crithidia become elongated and free-swimming (Fig. 2).

The addition of fresh toad serum agglutinates the crithidia and induces the development, after a day or two, of numerous trypanosoma forms with undulating membrane and posterior kinetoplast. In

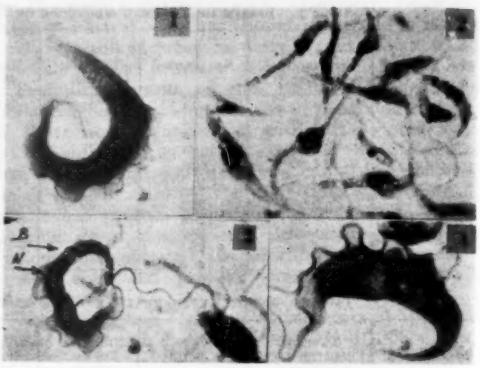

Fig. 1. Induced transformation of *Trypanosoma mega*: 1, blood-stream form in *Bufo regularis*; 2, culture form, crithidia; 3, trypanosoma form induced by toad serum; 4, trypanosoma form induced by calf serum. (Giemsa stain. × *c.* 1015)

1911, França[2] observed a similar phenomenon in *T. rotatorium*. This author transferred crithidia from the digestive tract of a leech into frog serum kept continuously agitated. He ascribed the transformation to the agitation and not to the serum.

We next noticed that the action was not specific of toad serum: the sera of various mammals, such as mouse, horse, calf, had the same action on the crithidia. This led us to choose calf serum for our next experiments.

Calf serum added to the culture medium in adequate proportion (50 per cent or more) agglutinates and kills the flagellates in a few minutes. The same serum heated to 56° C. for 39 min. agglutinates without lethal effect and, 24 hr. after its addition, numerous blood-stream forms appear in the culture (Fig. 4). Finally, this serum, exposed at 0° C. to large quantities of culture flagellates, has lost its specific agglutinins but retains its ability to change crithidia into trypanosoma form.

After dialysis, calf serum loses none of its form-changing activity. On the other hand, the serum fraction soluble in 50 per cent ethanol does not modify the form of culture crithidia.

The serum proteins were next fractionated by salting out with ammonium sulphate, followed by dialysis and lyophilization. Preliminary experiments showed that the activity is linked with the globulin fraction.

We observed that, in a culture, a certain number only of the crithidia were transformed into trypanosomes by the action of serum. This percentage seems to be closely connected with the age of the culture: a young culture, rich in dividing forms (rosettes), yields only very few trypanosoma forms. This would mean that, apart from the specific property of the serum, the transformation of the trypanosome requires a corresponding intrinsic factor. An analogy exists between this fact and the appearance of metacyclic trypanosomes at the end of the invertebrate cycle.

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Relationship between the Amine Contents of the Two Adrenal Glands of the Cat

WORKERS[1] vary in their methods of calculating the adrenaline and noradrenaline content of adrenal glands. Some express them in micrograms per unit weight of gland, some in micrograms per gland and some even in micrograms per kilogram of body-weight. Since, frequently, there is a difference between the weight of the left and of the right gland of each cat, it was thought desirable to determine whether the percentage of noradrenaline is the same in the two glands, and whether the total amine content is the same for both glands or whether the heavier gland contains more amine.

Both adrenal glands from thirty-six adult cats were dissected free of connective tissue, and 50 mgm./ml. extracts were prepared in 0·1 *N* hydrochloric acid. The adrenaline and noradrenaline content of each extract was assayed biologically, using the cat blood pressure and nictitating membrane as test preparations. The results were calculated by the formula of Bülbring[2]. At least two determinations were made on each preparation and the results were treated statistically.

As can be seen from Fig. 1, the percentages of noradrenaline in the right and left glands are equal. From the thirty-six pairs of results the mean percentage of noradrenaline in the left gland was 44·5 per cent and in the right gland was 44·0 per cent. The correlation between the pair of glands is independent of the degree of methylation and of any difference in the weight of the two glands.

In some cats, the two adrenals may not vary by more than a few milligrams. However, in others the difference may be considerable. In this series of experiments the greatest absolute difference in weight was 52 mgm. and the greatest difference, expressed as a percentage, was 36·4 per cent. In other experiments[3], absolute differences as great as 100 mgm. were observed.

As can be seen from Fig. 2, where the results from glands which differed in weight by more than 1 per cent are recorded, there is a much closer correlation between the amount of amine in the two glands when expressed as per gland than when expressed as per 100 mgm. of gland. This is true whether the difference in the weight of the two glands is small or large. Although only mean results are shown in the above two figures, the results from individual pairs of glands show the same picture.

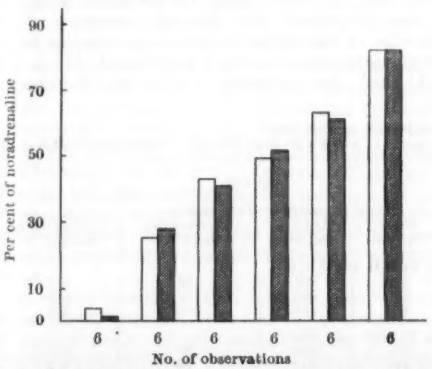

Fig. 1. Comparison of the percentage of noradrenaline in the left and right adrenal glands of the adult cat. The hatched area represents the left gland and the shaded area the right gland

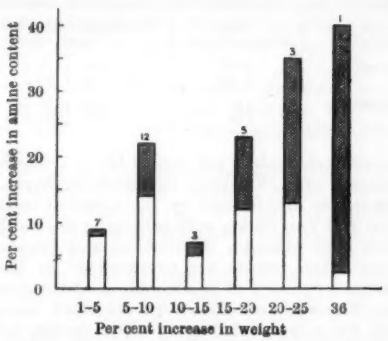

Fig. 2. Comparison of the amine contents of the two adrenal glands of the cat. The shaded area represents the difference in the amine content of the right and left glands, expressed as per 100 mgm. of gland, and the clear area represents the difference expressed as per gland. In all cases the difference is expressed as a percentage increase. The number above each column is the number of observations from which the mean value was obtained

Thus it may be concluded that, in the cat, the adrenaline and noradrenaline content of the two adrenal glands should be calculated as per gland and not as per unit weight of gland. This is of importance when one gland of the animal is used as a control and the effects of drugs on the other are studied[3].

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Comparative Hyperfibrinogenæmic Action of D- and L-Adrenaline

IN a previous work on the hyperfibrinogenæmic effect of several sympathomimetic amines, it was reported[1] that adrenaline, when injected subcutaneously into the rat, has the highest activity in increasing blood plasma fibrinogen. We have now compared the activity of D- and L-adrenaline in relation to the hyperfibrinogenæmic response. After a preliminary experiment to find roughly the relative hyperfibrinogenæmic effect of the two forms of adrenaline, the following experiment was carried out. Forty female albino rats of 150–200 gm. body-weight were divided by randomization into four groups of ten rats each. Two groups received subcutaneously respectively 0·03 and 0·06 mgm. of adrenaline (expressed as base)/100 gm. body-weight. The other two groups were injected respectively with 1 and 2 mgm. of D-adrenaline (base). 24 hr. later, the rats were bled from the aorta under pentobarbitone-sodium anæsthesia (4 mgm./100 gm. body-weight) using syringes coated with 'Dry Film 9987', clotting being prevented by the addition of 0·01 ml. of 30 per

Table 1

Substance	Dose (mgm./100 gm.)	Fibrinogen (mgm./100 ml.) ± stand. error
L-Adrenaline	0·030	285 ± 17·6
	0·060	343 ± 17·4
D-Adrenaline	1·0	285 ± 17·2
	2·0	338 ± 20·3

cent potassium oxalate per ml. of blood; the D- and L-adrenaline were Winthrop Research Products. The fibrinogen was determined by the classical technique of Cullen and Van Slyke, with ashing by the method of Campbell and Hanna[2], distillation and titration of ammonia. The results are summarized in Table 1. The relative potency of D-adrenaline as compared to L-adrenaline was calculated by standard statistical methods for a four-point assay. Our results indicate that the dextro-compound has 2·8 per cent of the activity of the lævo-compound, with the exact fiducial limits of 1·8 and 5·9 per cent. This potency ratio of 1 : 36, obtained for the hyperfibrinogenæmic effect of the dextro-compound in relation to the lævo-compound, is lower than the ratio 1 : 20 obtained by Tainter[3] for the pressor response in the cat. It is, however, comparable to the 1 : 30 to 1 : 40 ratio found by Fromherz[4] for the pressor response in dogs.

We thank Winthrop Products, Inc., New York, for the gift of the D- and L-adrenaline.

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Photoperiodism and Thermal Resistance of Goldfish

It is well known that the resistance of fish to extremes of heat or cold can be markedly altered by acclimatizing them to progressively higher or lower temperatures. In an attempt to discover the mechanism involved, it became evident that several factors in addition to thermal acclimatization may alter the resistance of goldfish to extreme temperatures. Diet[1] and size, sex and season[2] affect the thermal resistance of goldfish maintained at a constant temperature of 20° C.

Factors responsible for the seasonal differences are being investigated. Over a period of several years, goldfish maintained at a temperature of 20° C. and fed on a standard diet were relatively more resistant to cold in winter and to heat in summer. Cyclical seasonal changes in thermal tolerance seem to be at least partially independent of environmental temperatures. Since the seasonal variation in length of day was the only obvious environmental variable, experiments were designed to test the effects of different photoperiods.

In October 1955 two groups of goldfish (mean weight 14·2 gm.) were subjected to different photoperiods. The first group received 8 hr. illumination (70 ft. candles at the water surface) and 16 hr. darkness, while the second group received 16 hr. illumination (same intensity) alternating with 8 hr. darkness. The first situation corresponded to the hours of sunlight in winter, and the second to the sunlight period of summer. Temperatures varied from 18° to 20° C. in the room but were the same in all tanks. The diet was pablum and shrimp meal.

The thermal resistance of the two groups was compared after forty days and after fifty days. In tests of thermal resistance, the two groups (marked by distinctive fin clips) were placed together (fifteen of each group) in a lethal-temperature bath. The temperature in the cold bath fell from about 4° C. to 1° C.; that of the warm bath was about 36·5° C. Other details of testing were similar to those given elsewhere; fish here referred to as 'killed' or 'dead' are actually 'removals'.

In Table 1 we have recorded the number of minutes exposure required to kill different percentages of the samples. Thus, in the heat test *A*, 25 per cent of the short-day fish were dead at 31 min., while the same percentage of long-day fish survived until 41 min.—a difference of 10 min. in the 25 per cent lethal times. The temperature of the lethal bath at 41 min. was 36·5° C.; the initial temperature of this bath was 34·5° C. In the cold test, carried out at the same time, 25 per cent of the sample of short-day fish were dead at 198 min., while the same percentage of long-day fish had died at 102 min. The temperature of the bath at 198 min. was 1·2° C.

In detail, the table shows that the short-day period fish (winter fish) are consistently more resistant to cold and less resistant to heat, whereas the reverse is true of the long-day period fish (summer fish). The precise differences in lethal times may be varied by changing the severity of the test, as shown by the two sets of lower lethal temperature data. In each case, however, the thermal tolerance of the two groups of fish differs in a manner similar to the seasonal variations described elsewhere[3]. It is concluded that the seasonal variations in thermal

Table 1. Comparisons of Thermal Resistance of Goldfish
Short diurnal light period (8 hr.) or long diurnal light period (16 hr.) for 40 days (test *A*); and for 50 days (test *B*). Further description in text.

Per cent dead	Heat test: Initial exposure to death in min. Short-day fish	Heat test: Long-day fish	Heat test: Difference in lethal time	Heat test: Corresponding temp. (° C.)	Cold test: Initial exposure to death in min. Short-day fish	Cold test: Long-day fish	Cold test: Difference in lethal time	Cold test: Corresponding temp. (° C.)
Test *A*. Initial temperatures of lethal baths, 34·5° C. and 3·0° C.								
25	31	41	10	36·5	198	102	96	1·2
50	39	49	10	36·5	330	168	162	1·8
75	48	65·5	17·5	36·3	462	258	204	1·4
Test *B*. Initial temperatures of lethal baths, 35·5° C. and 4·0° C.								
25	67	71	4	36·9	372	342	30	0·8
50	77	88	11	36·1	446	418	28	0·2
75	86	119	33	36·5	492	461	31	0·5

tolerance previously noted in fish maintained under constant temperature conditions are photoperiodically controlled, probably through the pituitary gland. The endocrinology and biochemistry of the fish are now being investigated.

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Hormonal Depression due to Treatment of Animals with Chlorpromazine

IN an earlier paper, we have shown that in human patients chlorpromazine impairs the hypothalamus and through it the anterior pituitary lobe[1]. This depressing effect balances itself in accordance with the push–pull principle so far as the following tropins are concerned: follicle-stimulating hormone, luteinizing hormone, adrenocorticotropic hormone and thyroid-stimulating hormone, since they produce secondary hormones. This is impossible, however, with regard to luteotropic hormone and somatotrophic hormone, as neither of them produces peripheral secondary hormones.

The present communication describes the endocrine effects after three months of continuous treatment with chlorpromazine in animals which received subcutaneously 10 mgm./kgm. daily. For every group, five rats were used and the weights of their organs are given as average values. A detailed histological report on these effects will be published in collaboration with Prof. H. Ungar.

Follicle-stimulating hormone. (*a*) In infantile female rats it is only partly suppressed, as evidenced by spontaneous opening of the vagina on maturation and later by a tendency to permanent œstrous; the ovaries weighed 35 mgm. (controls 90 mgm.).

(*b*) In the male rat, the suppression is strong enough to produce atrophy of the testes (700 mgm. instead of 1,500 mgm.).

Luteinizing hormone. (*a*) In the female rat, suppression is complete, as no corpora lutea are formed.

(*b*) In the male rat, the suppression of interstitial-cell stimulating hormone is also complete, as the prostate and seminal vesicles become atrophied (500 mgm. instead of 2,000 mgm.).

Adrenocorticotropic hormone. In both sexes, the suppression is marked, as the adrenals weighed on an average 35 mgm. (control 45 mgm.).

Thyroid-stimulating hormone. In both sexes suppression is slight, since the thyroid glands weighed 28 mgm. as compared with the control (34 mgm.).

Somatotrophic hormone. In both sexes growth was definitely stunted by treatment. The females reached a steady weight at 95 gm. (controls, 125 gm.); the males at 125 gm. (controls, 200 gm.).

Subcutaneous injections of 5 rabbit units somatotrophic hormone (Wilson) daily along with the chlorpromazine treatment restored the weight within two months.

Luteotropic hormone. This hormone was tested in rabbits which received daily 0·5 mgm. progesterone. The second phase of the endometrium, which disappears normally after seventeen days treatment, was preserved for thirty-four days and longer by additional injections of chlorpromazine. This seems to indicate endogenous production of luteotropic hormone. Hence luteotropic hormone shows a pattern of reaction different from that of all other tropins[2].

After three months treatment there are no differences in pituitary weights between the animals treated with chlorpromazine and their controls (10 mgm.).

The fact that chlorpromazine was able to suppress the growth hormone may indicate that somatotrophic hormone is balanced by a secondary peripheral hormone. It has been suggested that such a relation exists with glucagon.

The above findings confirm the current view that chlorpromazine depresses the function of the hypothalamus. The endocrine disturbances thus brought about in the pituitary of animals may also appear in man if dosage is excessive.

We wish to thank the Specia Co., Paris, which supplied the Largactil, and the Wilson Laboratories, Chicago, which supplied the growth hormone. Our thanks are also due to Messrs. E. Zawojski, A. Eviatar and O. Hinckley for assistance.

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Intracellular Distribution of Choline Acetylase

WITH the development of methods for the measurement of choline acetylase independently of the enzymic formation of acetyl-coenzyme A[1–3], it has become possible to determine the intracellular distribution of the enzyme. In the present experiments, rabbit brain homogenates in 0·25 *M* sucrose were fractionated by differential centrifugation. In exp. 1 the procedure of Brody and Bain[4] was followed; in exp. 2, somewhat different centrifugal forces were applied as shown in Table 1. Each particulate fraction was washed by resuspension in 0·25 *M* sucrose and recentrifugation at the same speed; the washings were then pooled with the original supernatant for the next stage of the centrifugation.

Choline acetylase activity was determined by incubating the fractions in a system in which the substrate acetyl-coenzyme A had already been formed during a preliminary incubation at 37° C. of aged pigeon liver enzyme with citrate, acetate, choline acetylase and adenosine triphosphate[2,3]. After this induction period of 10 min. for the formation of acetyl-coenzyme A, the brain fraction to be tested was added to the system, incubation continued for a further 60 min. and the amount of acetylcholine formed determined by assay (frog rectus abdominis).

Whole homogenates tested in this way have only one-quarter to one-half of the activity of extracts made from acetone-dried brain. However, when they are treated with ether (0·2 ml./ml.), a procedure used in earlier studies on the synthesis of acetylcholine[5,6], the activity of the homogenates is equivalent to that obtained with acetone powders. The

Table 1. The Activity of Choline Acetylase in Fractions of Rabbit Brain Homogenates

Centrifugal force, g (time in min.)	Exp. 1. ACh synthesis by centrifugates		Exp. 2. ACh synthesis by centrifugates	
	μgm./gm. brain/hr.	Per cent of total	μgm./gm. brain/hr.	Per cent of total
600 (10)	—	—	18	3
800 (10)	62	8	—	—
1,500 (10)	28	4	—	—
12,000 (20)	400	52	—	—
15,000 (30)	—	—	441	69
25,000 (60)	64	8	42	7
Final supernatant	214	28	134	21
Total of fractions	768	100	635	100
Whole homogenate	880		705	

isolated fractions are also maximally active only after ether treatment, and the results shown in Table 1 refer to values so obtained.

The results given in Table 1 show that the sum of the activities of the separate fractions is equivalent to about 90 per cent of the activity of the whole homogenate. The fraction with the highest activity is that sedimented at 12,000–15,000 g. Using biochemical and histological criteria, Brody and Bain[4] obtained evidence that this fraction of rabbit brain homogenates contains only mitochondria; histological examination of our preparations confirms this finding. The mitochondrial fraction contains 50–70 per cent of the enzyme activity. Evidence that the enzyme is firmly bound to the particles sedimented at 12,000–15,000 g has been obtained by demonstrating that little or no activity is lost from this fraction after repeated washing. The only other fraction containing an appreciable proportion of the activity is the final supernatant (21–28 per cent); the remaining activity is distributed between the other fractions.

This evidence for the presence of choline acetylase in mitochondria is a further step in understanding the metabolism and function of acetylcholine in nervous tissue.

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Cholinesterase and Sodium Transport by Frog Muscle

In a variety of tissues (frog skin[1], red cells[2], *Chironomus* anal papillæ[3], and *Eriocheir* gills[3]) the active transport of sodium is blocked by inhibitors of cholinesterase. This communication concerns the role of cholinesterase in the sodium pump of the sartorius muscle of the frog, *Rana pipiens*. Sodium transport is readily demonstrated by placing the muscle in a Ringer's solution in which one-half of the sodium chloride has been replaced by sucrose[4]. Though the concentration of sodium in this sodium-deficient Ringer's still exceeds that within the muscle fibre, the muscle responds by actively transporting sodium ions into the external medium, so that after 30 min. the sodium content of the muscle, measured by flame photometry, has markedly decreased.

Table 1. The Sodium Content of Muscles after 30 min. in Sodium-deficient Ringer's at 25° C. Sodium determined by Flame Photometry; Muscle Water determined by the Difference between Wet and Dry Weights of the Muscle

Inhibitor	Sodium (m.equiv./kgm. muscle water) ± S.E.
None	23 ± 1
Previously exposed for 15 min. to 5×10^{-4} *M* hexaethyl tetraphosphate	35 ± 2
10^{-3} *M* physostigmine in sodium-deficient Ringer's	34 ± 2
Exposed to 10^{-3} *M* physostigmine for 30 min., washed and transferred to sodium-deficient Ringer's	22 ± 3
10^{-3} *M* prostigmine in sodium-deficient Ringer's	25 ± 2

This decrease in sodium content was prevented by previous exposure of the muscle to the irreversible anti-cholinesterase hexaethyl tetraphosphate, or by the addition of the reversible inhibitor physostigmine to the sodium-deficient Ringer's (Table 1). The block produced by physostigmine was reversed when the muscles were washed after exposing them to the inhibitor. However, a third anti-cholinesterase, prostigmine, failed to block sodium extrusion. Since it is known that quaternary nitrogen compounds, like prostigmine, are unable to penetrate the membranes of excitable tissues[5], we can conclude that only the anti-cholinesterases which penetrate into the muscle fibre and inhibit the intracellular enzyme are capable of blocking the sodium pump.

Though these experiments suggest that inhibitors of intracellular cholinesterase block sodium extrusion, they do not establish that cholinesterase participates in the pumping mechanism. Inhibitor studies, as Danielli has stressed[6], must be supported by evidence showing that the inhibitor actually does lower the activity of the enzyme and that the decrease in enzymatic activity is paralleled by a decrease in the rate of active transport.

Therefore, the effects of graded concentrations of physostigmine on the transport of sodium and on the activity of cholinesterase were measured. As is shown in Fig. 1, when the concentration of physostigmine was decreased the amount of sodium

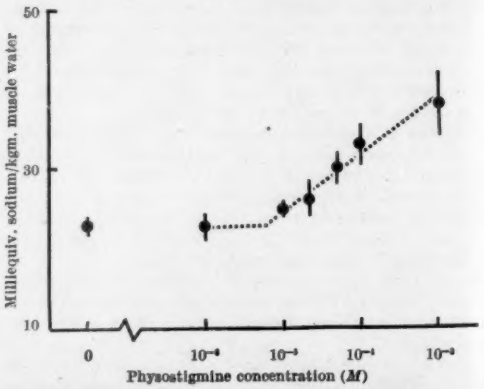

Fig. 1. The mean sodium content of the muscle water—after 30 min. in sodium-deficient Ringer's—as a function of the concentration of physostigmine. In every experiment 10^{-3} *M* prostigmine was present. The line between 10^{-2} *M* and 10^{-1} *M* physostigmine was calculated by the method of least squares. The vertical lines on the points indicate the standard errors

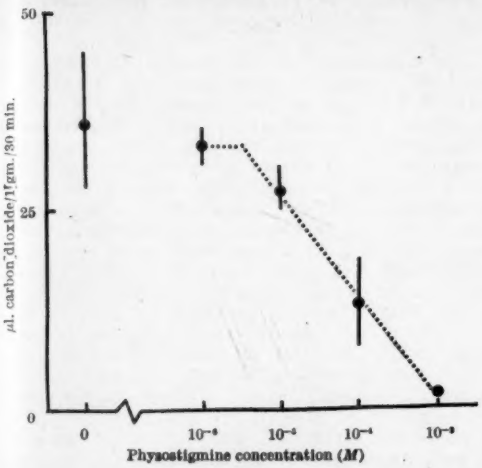

Fig. 2. The mean cholinesterase activity of muscles as a function of the concentration of physostigmine. Activity was measured manometrically with 0·015 *M* ethylchloroacetate as the substrate. In every experiment the medium contained 10^{-4} *M* prostigmine and the muscles were exposed to the inhibitors for 60 min. before the addition of the substrate. Symbols and method of plotting as in Fig. 1

remaining in the muscle decreased, until in 10^{-5} *M* physostigmine the sodium transport was scarcely affected. The measurements of cholinesterase activity were also taken on intact muscles, using ethylchloroacetate as a substrate[7]. Ethylchloroacetate can penetrate into the muscle fibres, and therefore the cholinesterase activities of intact muscles and of homogenates, when measured with this substrate, are almost identical. The results are presented in Fig. 2. In each instance 10^{-3} *M* prostigmine was also present to inhibit the extracellular cholinesterase which, though it makes up 40–60 per cent of the total enzyme activity, has already been shown to be unimportant in sodium transport. However, the concentrations of physostigmine which inhibited sodium extrusion produced a comparable inhibition in the activity of the intracellular cholinesterase. In fact, the concentrations of physostigmine producing a 50 per cent inhibition of sodium transport and a 50 per cent inhibition of intracellular cholinesterase were almost identical.

The sodium transport in frog muscle was also inhibited by iodoacetic acid[4]. As is shown in Table 2, iodoacetic acid is not as effective an inhibitor as are the anti-cholinesterases. Moreover, the block produced by iodoacetic acid was by-passed by adding pyruvate to the medium. In normal circumstances the sodium pump was scarcely affected by cyanide, but this inhibitor was strongly effective when iodoacetic acid and pyruvate were present. Clearly any source of high-energy phosphate bonds is sufficient: either glycolysis in the presence of cyanide or the Krebs cycle when pyruvate is available.

Table 2. The Sodium Content of Muscles following 30 min. at 25° C. in Sodium-deficient Ringer's which contained Metabolic Inhibitors

Inhibitor	Sodium (m.equiv./kgm. muscle water) ± S.E.
10^{-3} *M* iodoacetic acid	28 ± 1
10^{-3} *M* iodoacetic acid; 10^{-3} *M* pyruvate	23 ± 2
10^{-3} *M* potassium cyanide	25 ± 1
10^{-3} *M* iodoacetic acid; 10^{-3} *M* pyruvate; 10^{-3} *M* potassium cyanide	34 ± 3

In summary, the present data indicate that the activity of cholinesterase is prerequisite for the working of the sodium pump in muscle. It is apparent that a source of high-energy phosphate bonds is also essential, though the means by which this energy is invested in the transport of sodium remains obscure.

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A Simple and Effective Movement-restricting Collar

It is frequently vital in research to restrict the experimental animal's movements and to keep him from damaging the experimental site, such as an externalized organ, tube or catheter. Much valuable work and time is often nullified in a short time by the animal pulling at the operative site which he will invariably do if he has access to the area.

In our work on ureteral regeneration it is necessary to prevent the dog from reaching and pulling the ureteral splint which is necessarily exposed on the flank for six weeks. Muzzles, pneumatic collars, disk collars and heavy dressings have been employed without success and with some discomfort to the animal as they would constantly worry the restricting apparatus. Since 60–70 per cent of our original operated animals pulled their tubes, a new collar was devised and has proved very satisfactory during the past eight months.

A template of heavy wrapping paper is made to fit to the size of the dog (Fig. 1). The measurements to fit the various size dogs from the smallest to the largest are accomplished with comparative ease as the collar is sufficiently adaptable in three sizes from large to small. This is traced on 18-gauge aluminium, which cuts easily with tin shears. ¼-in. holes can be drilled or punched with a common nail. The holes are measured at one and one-half inch intervals and one inch from the edge of the entire periphery. These are made to hold felt or sponge rubber, and we have found the former to hold best. Continuous No. 10 cotton thread holds up well under most conditions. At the ends, four ¼-in. holes are made on the overlapping end and two or three rows are made on the underlying flap. This gives an additional chance for adjustment or to use the collar on other animals. Two large holes, ½ in., are made at the point of the collar to permit the fastening of the chest ropes. This is an essential part of the collar to prevent rotation, as the collar is made to allow the dog free access of motion in all quadrants except the operation site. The flange can be changed or moved to suit the need. The chest band can be simply a short rope

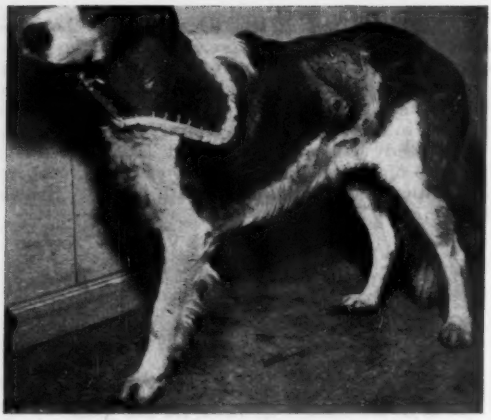

Fig. 1. Dog with movement-restricting collar attached. Note the flange extends well over the scapula

placed through the ½-in. hole on one side of the collar and brought across the chest in the back of and between the fore-leg to the hole on the opposite side of the flange. A canvas strap three inches wide with metal loops to accommodate snaps or short leather thongs which are crossed under and between the forelegs can be employed as an alternative to the rope.

This collar has proved very satisfactory by first being well tolerated by laboratory animals under conditions of restricted quarters. The dog fretted very little and apparently had sufficient latitude of movement to enable reasonable activity and comfort in eating and resting. These dogs were observed for a continuous six-week period, at the end of which time the fur and skin under the collar was not irritated in any way.

The optimum requirements for such a collar are for the lightest possible material which would produce the least amount of bulk. The only other effective type is the disk collar, but it was seen in our series of animals to be only 30 per cent effective against 92 per cent with the wrap-around type. A comparison of some values shows the disk type to weigh 1¾ lb. against 8 oz. Moreover, the cost of the latter is much lower. The ease of application and construction is far greater in the wrap-around and it can be changed rapidly if the occasion demands.

Two factors have to be avoided: (1) To make the strings to the chest strap secure, as without these the collar can rotate on the neck, thus allowing the animal access to the protected site. (2) To make the flange sufficiently long to restrict motion successfully.

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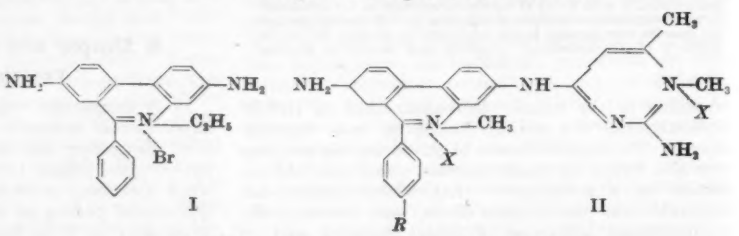
Prophylaxis of Trypanosome Infections in Cattle

The introduction of 'Ethidium' (I) in 1952 made available to veterinarians in Africa a drug with very high therapeutic activity against the two most important trypanosomes of cattle, *Trypanosoma congolense* and *T. vivax*, and this drug is now widely used. There still seemed to be the need, however, for a drug which would confer a prolonged period of protection to dosed animals, and we have therefore, worked to this end. One particular series of drugs (II) showed, in mice, therapeutic activity of a very high order, and also a prophylactic action greater than that of any other drug available. Two of the most active of this series, '*R.D.* 2787' and '*R.D.* 2801', were sent to Africa for trials in cattle. '*R.D.* 2801', which had appeared the better of the two in tests in mice, has shown considerable promise in tests in Tanganyika and in Nigeria, against both *T. congolense* and *T. vivax*. In one trial, for example, a single dose of 2 mgm./kgm. protected cattle for at least six months. Trials are still in progress, and full results of both these trials and of our laboratory findings will be published elsewhere.



I II

R.D. 2787 $R = NO_2$ X = an anion such as bromide,
R.D. 2801 $R = NH_2$ chloride, methanesulphonate, etc.

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Dehydrochlorination of DDT by Resistant Houseflies and Mosquitoes

The recent characterization of DDT dehydrochlorinase in resistant houseflies[1] has prompted an investigation of this enzyme and of the production of 2,2-bis(*p*-chlorophenyl)-1,1-dichloroethylene (DDE) in mosquitoes, in which DDT-resistance is now developing[2]. As an initial step, two strains of resistant houseflies were assessed for DDT-dehydrochlorinase content. The DDT-45 strain showed no less activity than originally reported[1], the DDE production in 3 hr. by the equivalent of six flies averaging 98 μgm. for homogenates and 52 μgm. for acetone powders. The Dilan strain, developed by two years of dilan pressure without any exposure to DDT, showed an enzymic DDE production of 100 μgm. for homogenates and 34 μgm. for acetone powders. This Dilan strain resembled the DDT-45 strain in having an *LD*90 exceeding 50 μgm. and being able to convert 90 per cent of 10 μgm. of DDT topically applied to DDE in 24 hr.

Two instances of DDT-resistance in mosquitoes were then investigated. (1) Resistant salt-marsh

mosquitoes (*A. taeniorhynchus* admixed with *A. sollicitans*) from Cocoa Beach, Florida, where DDT-resistance was first reported in 1949 and which has since been liberally treated with lindane, dieldrin and heptachlor[3]; they were compared with salt-marsh mosquitoes from the Oatland Island marshes, Savannah, Georgia, where DDT has never been used. (2) Resistant *Aedes aegypti* from El Socorro and Aranguez[4], Trinidad; they were compared with a normal laboratory stock (*CD* strain) obtained from Camp Detrick, Maryland.

The susceptibility of these strains was determined by exposing fourth-instar larvæ for 24 hr. to various concentrations of DDT added in 1 c.c. of acetone to 1 litre of tap water in enamel pans. The *LC*50 values were thirteen times greater than normal for the salt-marsh mosquitoes from Cocoa Beach, and five hundred times greater than normal for the *A. aegypti* from Trinidad. Accordingly, 140–200 larvæ of each strain were exposed to DDT in three 1-litre pans of tap-water for 24 hr., and their DDT uptake and DDE production were determined by the Schechter–Haller method after washing them in a stream of distilled water, grinding them in a mortar with sand and anhydrous sodium sulphate, extracting with carbon tetrachloride and purifying in a 'Celite'-sulphuric acid column.

Table 1

	A. taeniorhynchus		*A. aegypti*	
	Normal	Resistant	Normal	Resistant
*LC*50. p.p.m. DDT	0·003	0·04	0·004	2·0
Larvæ exposed, No.	140	140	200	150
Concentration, p.p.m. DDT	0·005	0·03	0·003	1·0
DDT uptake (μgm.)	5·6	73·3	2·0	1,553
DDE produced (μgm.)	2·4	15·9	1·3	149·3

Both normal strains produced an insignificant amount of DDE, their uptake of DDT being small. The resistant strains, exposed to higher concentrations, accumulated much DDT; the resistant *A. aegypti* took up slightly more than one half the 3 mgm. of DDT to which the 150 larvæ were exposed. Both resistant strains produced considerable amounts of DDE, the ratio DDE/DDT being 22 per cent for the salt-marsh mosquitoes and 10 per cent for *A. aegypti*. On the average, one larva of the resistant *A. aegypti* produced approximately 1 μgm. of DDE in 24 hr. In comparison, an adult housefly of the *DDT*-45 strain, which weighs 4·5 times as much, can produce 4·5 μgm. of DDE per 24 hr. from DDT topically applied[5].

DDT-dehydrochlorinase activity was then assessed by means of acetone powders and homogenates at various concentrations incubated with DDT in ethanol or on glass beads. A total of thirteen such tests were made, but in no case was there any significant production of DDE. It is therefore suggested that the DDT-dehydrochlorinase of these mosquitoes requires different conditions from these suitable for housefly material. This view is supported by the recent observation of Kearns that homogenates of the resistant Mexican bean beetle, *Epilachna varivestris*, will not produce DDE under conditions suitable for the housefly, but can be induced to do so by a mixture of eighteen ions and compounds selected for their liability to activate or protect against inhibition (Kearns, C. W., personal communication).

The detailed results of this investigation are being made available by the World Health Organization.

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Carotenoids and Reproduction in *Pyronema confluens*

Robinson[1] found that light was necessary for both orange pigmentation and fruit-body (apothecium) formation in *Pyronema confluens* Pers. ex Tul. Since he was unable to obtain these effects separately, he postulated a causal relationship between them. Later work on the effects of light on *Pyronema*[2] has not been concerned with testing this hypothesis. Recent work by one of us[3] has shown that there is no direct relationship between pigmentation and spore production in *Fusarium oxysporum*, and it appeared useful, therefore, to investigate the problem in *P. confluens*.

Apothecium formation was observed using a double-dish technique[4]; the inner dish contained a medium favouring vegetative growth (Czapek–Dox agar with 2 per cent glucose) and the outer dish a medium favouring reproduction (plain agar). Inoculation of the inner dish with wild-type *P. confluens* and exposure either to daylight or to a lamp emitting light between 360 and 580 mμ gave rise to a faintly orange mycelium, and to orange apothecia in the outer dish.

Exposure of the *P. confluens* to a lamp emitting ultra-violet radiation between 300 and 400 mμ produced a white mycelium and white apothecia. When grown in darkness, the mycelium was again not coloured; but in this case no apothecia were formed.

The pigments, both from coloured apothecia produced as described, and from surface mycelial mats, without apothecia, grown in the light in Roux bottles containing a liquid Dox medium with 5 per cent glucose, were extracted with cold acetone. The pigments were transferred into light petroleum by addition of water. After saponification with methanolic potassium hydroxide and partition with water and petrol two groups of pigments were found. One was present in the petrol and the other remained in the alkaline hypophase.

Chromatographic analysis of the epiphasic portion showed that it contained five pigments of which four have been identified. They are β-carotene, γ-carotene, torulene and a *cis*-isomer of the latter, probably neotorulene[5]. This component was slightly less adsorbed than torulene; its absorption spectrum (maxima 451, 477 and 509 mμ in light petroleum) yielded on iodine catalysis a curve indistinguishable from that given by torulene under similar conditions (455, 480 and 511 mμ). The fifth component, which has a similar absorption spectrum (maxima 456, 484 and 516 mμ in light petroleum) to that of torulene, could not be separated, on chromatograms of either calcium car-

bonate or cellulose powder, from a celaxanthin-like fraction[6] we have isolated from berries of *Celastrus rosthornianus*.

The hypophasic pigments were extracted with petrol after acidification of the methanolic alkali. The absorption spectrum of the total fraction corresponded with values given for torularhodin, an acidic carotenoid fraction found in various Rhodotorulae[7]. We were able to separate this fraction into two major bands using an adsorption chromatogram of cellulose powder. The two fractions had similar absorption spectra, the maxima (in light petroleum) being: lower band, 496 and 526 mμ, inflexion at 460 mμ; upper band, 497 and 530 mμ, inflexion at 460 mμ.

Fractions similar to both these acidic compounds have been found in cultures of *Rhodotorula rubra* (J. F., unpublished observations).

Bean and Brooks[8] reported an albino *Pyronema* capable of normal reproduction. We have produced an albino mutant by exposing ascospore suspensions to an ultra-violet lamp emitting mainly at 254 mμ. The albino mutant required light to produce apothecia; but on examination of the acetone extracts no colourless polyenes were found. We were also unable to detect colourless polyenes in unilluminated cultures of either wild-type or albino *P. confluens*.

We conclude that in *Pyronema confluens* we have two distinct and unrelated photochemical effects. One leads to the synthesis of carotenoids and the other to the formation of apothecia. As a result of these observations we suggest that Robinson's hypothesis is invalid.

We wish to thank Drs. E. C. Bate-Smith, N. F. Robertson and T. Swain for their interest in this work.

For one of us (J. F.) the work described in this paper forms part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Isolation of Plant Starches

In the course of studies on the apple fruit, the need arose for a quantity of apple starch. None of the published methods of preparation we tried was entirely satisfactory, and a simple, rapid method was evolved which seems to have a general application. Starches have been prepared from a number of materials, which are listed in Table 1, together with the nitrogen content of the starches.

The tissue was ground in a Waring blendor with sufficient cold 1 per cent solution of ammonium oxalate to produce a thin mixture, which was then filtered through muslin. This process was repeated on the residue. Occasionally a third extraction was required in order to remove the starch completely. The suspension was centrifuged in conical tubes at 200–300 *g*. Starch became packed in a tight layer at the bottom, and impurities were readily removed from its surface by gentle washing. The starch was suspended in water, centrifuged out at about 1,500 *g* and the surface washed. This was repeated: a total of four or five times was sufficient for the materials listed in the table. The presence of impurities on the surface of the starch layer was easily seen. Occasionally a small amount of impurity settled below the starch. This was removed by suspending the whole in a small amount of water and centrifuging three or four times for a few seconds, the suspension being poured each time into a clean tube. The purified starch was washed finally with alcohol and ether.

Table 1

Source	Nitrogen (per cent dry wt.)	Source	Nitrogen (per cent dry wt.)
Green apple	<0·01	Chestnut	0·02
Green tomato	<0·01	Butternut root bark	<0·01
Carrot	0·03	Sumac bark	0·06
Potato	0·03	Marigold leaves	0·06
Wheat (mature)	0·05	Tobacco leaves	0·02
Maize (mature, soaked)	0·06		

In polarized light all starches except those from leaves showed a characteristic maltese cross. The granules of the leaf starches were flat and showed rotation of polarized light only when viewed on edge. Examination of stained preparations of all samples indicated a high degree of purity and the granules were undamaged mechanically.

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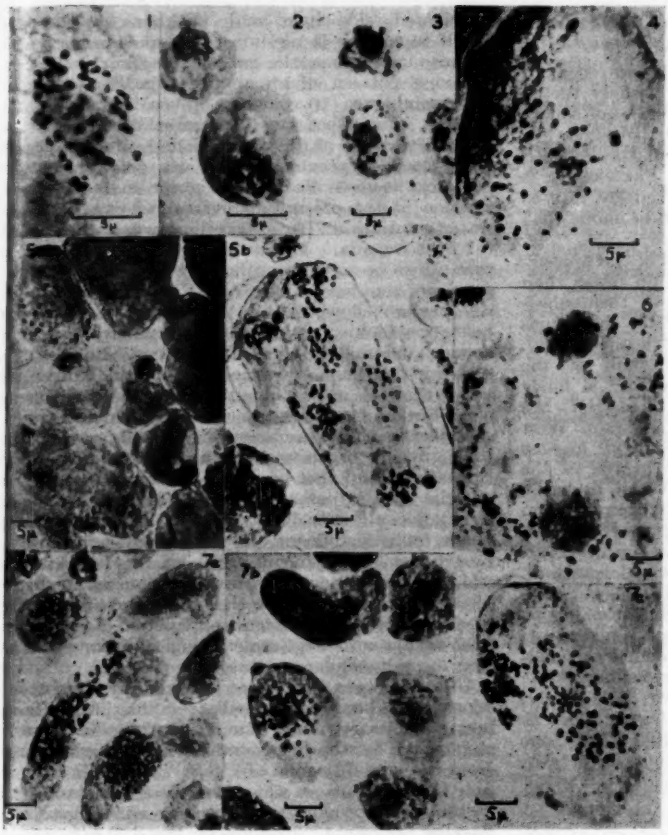
Chromosome Counts in the Rhodophyceae

Nuclei of the Rhodophyceae are often difficult to observe either on account of their small size, the presence of excessive mucilage or the cartilaginous nature of the tissues in which they occur. Using squash techniques and staining with ferric ammonium sulphate and aceto-carmine[1], or with aceto-carmine alone, both mitotic and meiotic divisions have been observed in a number of red algae.

January and February were found to be good months for obtaining rapidly growing tissues, antheridial material being especially suitable. Fixation was in acetic–alcohol (1 : 3) or Carnoy's fluid.

Chromosome counts of the following species, arranged according to the Preliminary Check List of British Marine Algae[2], have been made.

	n	2*n*	Previous counts (ref. 3)
Cystoclonium purpureum (Huds.) Batt.	—	50	—
Rhodymenia palmata (L.) Grev.	21	—	—
Ceramium rubrum (Huds.) Ag.	34	—	—
Cryptopleura ramosa (Huds.) Silva.	30	—	—
Membranoptera alata (Huds.) Stackh.	32	—	—
Delesseria sanguinea (Huds.) Kylin (ref. 4)	31	—	2*n* = 40
Laurencia hybrida (DC.) Lenorm ex Duby.	31	—	2*n* = 40
Laurencia pinnatifida (Huds.) Lam.	29	58	2*n* = 40
Polysiphonia elongata (Huds.) Harv.	37	—	—
Polysiphonia lanosa (L.) Tandy.	27	—	—
Polysiphonia nigrescens (Sm.) Grev.	30	60	—
Rhodomela confervoides (Huds.) Silva.	32	—	2*n* = 40



1, *Cystoclonium purpureum* (Huds.) Batt., diploid nucleus. 2, *Rhodymenia palmata* (L.) Grev., mitosis in cell of haploid thallus. 3, *Polysiphonia nigrescens* (Sm.) Grev., mitotic prophase in cell from antheridial tissue. 4, *Polysiphonia elongata* (Huds.) Harv., division in a large cell from young tissues of haploid plant. 5*a*, *Delesseria sanguinea* (Huds.) Kylin, mitosis in cells of young fronds on female thalli. 5*b*, *Delesseria sanguinea* (Huds.) Kylin, simultaneous division of six nuclei in large cell from central part of thallus. 6, *Rhodomela confervoides* (Huds.) Silva. (*R. subfusca* (Woodw.) Ag.), interphase of meiosis in the tetrasporangium. 7*a*, *Laurencia pinnatifida* (Huds.) Lam., mitosis in haploid plant. 7*b*, *L. pinnatifida*, mitosis in diploid plant. 7*c*, *L. pinnatifida*, simultaneous division in trinucleate cell of diploid plant

Laurencia pinnatifida and *Rhodomela confervoides* both have large sporangial nuclei which are easily studied at meiosis.

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Apical Cell of Salt Marsh Fucoids

In 1950, S. Baker described the universal occurrence of a three-sided apical cell in a number of salt marsh fucoids[1]. Since no further publication on the anatomy of these plants has appeared, the following observations may be of interest.

On several occasions *Fucus vesiculosus* L. var. *muscoides* Cotton was collected from Clachan Sound, Argyllshire, where the plants form a tufted carpet stretching high up the shore together with *Armeria maritima*. An examination of these plants showed a series in development from those with a cylindrical thallus only 1 cm. in length which branched profusely in a very irregular manner to those 5 cm. or more in length, with branching confined to one plane and with a flattened thallus showing some differentiation into midribs and wings. Sections through the apices of these plants showed a parallel series in development. The smallest plants had a very shallow apical groove at the base of which no distinct apical cell could be discerned. Slightly larger forms had the apical groove lined with hairs but still no differentiation of a distinct apical cell. The smallest of the forms which showed a tendency to flattening of the thallus had a distinct three-sided apical cell such as Baker describes[1]. Sometimes this was accompanied by apical hairs still lining the apical groove. Small attached plants nearby had a four-sided apical cell, as is characteristic of the adult fucoid thallus. In fact, the apices of these plants of *F. vesiculosus ecad muscoides* demonstrated the successive stages through which the apex of the attached form of *F. vesiculosus* passes during its development from the sporeling to the adult thallus[2].

The retention of the juvenile form of the apex is accompanied by little secondary activity of the various tissues. Very rarely was any evidence of secondary cortex seen, and few, if any, secondary hyphæ were found. Where the latter did occur, they often arose in tufts from a single cell of the innermost cortex and ramified in all directions through the thallus and not mainly towards the base of the plant as in attached forms. Occasionally hyphæ penetrated through the base of the plant, but these were not developed in sufficient numbers to interweave and form an attaching disk.

Baker and Bohling[3] ascribed the origin of salt marsh fucoids to the production of adventitious branches from cast-up thalli, the branches separating with the decay of the parent plant. The anatomical structure of these plants of *F. vesiculosus* var. *muscoides* suggests the possibility that they originated from fertilized eggs which were cast high up the shore by spray and exceptional tides, into a zone unfavourable for normal growth and development. Under these conditions they survive and grow slowly, retaining the juvenile form and structure of the species and never reaching maturity and the formation of reproductive cells.

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The Indo-Pacific Loggerhead Turtle in Tasmanian Waters

THERE appears to be only one published record of a chelonian in Tasmania[1], that of a leathery turtle, *Dermochelys coriacea* (Linné, 1766), which came ashore at Fortescue Bay in March 1889 (specimen in Tasmanian Museum, Hobart). From unpublished information supplied by Mr. John Fazackerly, it seems probable a large turtle observed by him to emerge from the sea at this locality in or about 1945 was a second example of this species.

We are now able to present reports of the appearance, within the past five years, of no fewer than eleven other turtles on the coasts of Tasmania—three entries being based on available specimens or parts thereof, the remainder on hearsay only. Material examined comprises: (1) skull of the first animal to come under our notice, a fairly fresh example found stranded by one of us (B. C. M.) about half a mile north of Mount Cameron West on November 24, 1951; (2) skull and greater part of the carapace from near the mouth of the Arthur River (Mr. Bailey, per Mr. M. Olsen, probably November 1951); (3) complete young animal from Adventure Bay, Bruny Island (Tasmanian Museum, Hobart, August 24, 1955). These have been determined as the Indo-Pacific red-brown loggerhead, *Caretta caretta gigas* Deraniyagala, 1933. Reports, unsupported by material, but thought probably to be this species (or this species and the green turtle ?) comprise: (4–7) four individuals stranded at Studland Bay (Mr. G. Wainwright, about September 1951); (8) one swimming near Stanley (Mr. M. Hardy, 1951); (9) one stranded at Port Davey (Mr. C. Clayton, February or March, 1940); (10) one stranded near the mouth of the Arthur River (Mr. Bailey, date unknown); (11) one stranded at Currie, King Island (Mr. R. Clarke, 1951).

A paper dealing directly with the records enumerated above will appear in Vol. 90 of the *Papers and Proceedings of the Royal Society of Tasmania*; and it is hoped a further study of some of the problems raised by an examination of the material will later be published elsewhere.

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Extraneous X-Ray Diffraction Patterns from Algal Flagella

WE should like to sound a warning that might save other workers in this new and difficult field from some of the troubles that have beset our own investigations. Our aim has been to obtain X-ray diffraction diagrams of oriented preparations of the flagella of algæ, sperm, etc., of a standard comparable with those already obtained with bacterial flagella[1], and it was in fact believed that an encouraging advance towards this end had been achieved a few years ago[2]. Now, however, it has become apparent that it is much easier to discover diagrams of metabolic by-products and various other artefacts than of the flagella substance proper.

For example, flagella prepared from *Polytoma* grown in yeast/acetate/'Bacto-tryptone'/distilled water give a clean though non-specific protein diagram (diffuse, disoriented 'side-chain' and 'backbone' reflexions); but if tap water is used instead—and Leeds water is quite soft—then the protein diagram is lost in a strong pattern of an apatite type, to judge by its resemblance to patterns given by bone and dentine. The effect was finally tracked down to the intervention not of tap water alone but of tap water plus 'Bacto-tryptone'; but it was found that the pattern was given also by the lighter, more flocculent fraction of the precipitate formed when a distilled-water solution of 'Bacto-tryptone' was treated with 0·1 *M* ammonia. In the electron microscope this precipitate seemed amorphous, but electron micrographs of the flagella which gave the apatite-type X-ray pattern showed them to be crusted over with hexagonal-looking platelets—built up more slowly, of course, and under the conditions generated by the growing flagella. These conditions are known to bring the *p*H up to about 9, but evidently some contribution from the tap water is involved too.

Probably these results mean nothing more than that growing organisms produce things other than themselves, and that one must therefore watch with especial care in pioneer X-ray studies of this kind; but they could conceivably be pointing to something much more significant, for the artefact here is a by-product of organisms growing on constituents which include 'Bacto-tryptone', a pancreatic digest of casein; and it may be that the 'bone-like' nature of the pattern really is an expression of a remote relationship with large-scale biological apatite formation in multicellular creatures.

In any event, a more immediately important consequence has been the realization that it must have been 'Bacto-tryptone', too, that was ultimately responsible for the X-ray pattern we thought[2] came from the actual flagella of *Polytoma*, etc. It is clear now that this pattern was not authentic, but was of a metabolic by-product trapped in, or adhering to, the flagellar structure. Because of the difficulty of reproducing exactly the conditions and materials of the earlier experiments it is not certain exactly how, but the fact remains that a roughly similar pattern is given by fresh 'Bacto-tryptone', and a very similar pattern by what is left when the supernatant from an algal culture has been evaporated to dryness.

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Sterculic Acid and its Halphen Reaction

THE structure of sterculic acid has recently been confirmed in this laboratory[1] as (I), proposed by Nunn[2], rather than as (II), suggested by Verma, Nath and Aggarwal[3].

$$CH_3—(CH_2)_7—C{=\!=}C—(CH_2)_7COOH \qquad (I)$$
$$\diagdown\ \diagup$$
$$CH_2$$

$$CH_3—(CH_2)_6—CH—CH—CH=CH—(CH_2)_7COOH \qquad (II)$$
$$\diagdown\ \diagup$$
$$CH_2$$

This investigation revealed a band at 5·35μ in the spectrum of fresh sterculic acid, which is believed to

be characteristic of a *cyclo*propene group. A strong band was also present at 9·92μ, as reported by other workers[3,4]. The latter band has been assigned by Verma *et al.*[3] to the *cyclo*propane group conjugated with a C=C double bond as in (II), by analogy with the absorption reported for this group at 9·9μ by Van Volkenburgh *et al.*[5] from the spectrum of vinyl-*cyclo*propane vapour. A more accurate value for this band would seem to be that of Slabey[6] at 9·77μ, since it was obtained from a considerably better resolved spectrum of the same substance taken in solution.

Five other similarly conjugated *cyclo*propyl alkenes also have bands at 9·77–9·79μ, while the corresponding alkanes absorb at 9·82 or 9·83μ[7]. These values are all in close agreement with that found for dihydrosterculic acid at 9·80μ. However, the shift in wavelength of the *cyclo*propane group resulting from conjugation does not support structure (II) for sterculic acid; this shift, which was noted in one instance by Dijkstra and Duin[4], seems to be generally smaller than, and in the opposite direction to, that found in the transition from dihydrosterculic to sterculic acid.

Verma *et al.*[3] have stated that the Halphen reaction which is given by many seed oils is possibly due to some component of the non-saponifiable matter present in the oil. However, the reaction is given by fresh sterculic acid as well as by *Sterculia foetida* oil. Recently, too, the positive test obtained with cotton-seed oil has been attributed by Gunstone[8] to the presence of very small amounts of an acid with a *cyclo*propene ring; and Shenstone and Vickery[9] have found on testing the oils of two *Malva* sp. that the Halphen reaction is given invariably by the saponifiable fraction, and is due to an unsaturated acid present to about 3 per cent of the total mixed fatty acids. This acid, like sterculic acid, shows a prominent band at 9·92μ. It seems probable that the positive test found with so many other seed oils is also due to acids similar to these, present perhaps in small amounts only, for the test is very sensitive.

The addition of sulphur and amyl alcohol does not appear to be essential for the Halphen test. A solution of sterculic acid in distilled carbon disulphide, which was left for several weeks at room temperature, was already slightly orange on the day after its preparation, and quite a bright orange-red after four weeks. The reaction taking place was definitely associated with the presence of the *cyclo*propene ring in the sterculic acid: no colour was given by the polymerized acid, in which this ring had been destroyed[1], and the bands at 5·35μ and 9·92μ disappeared progressively from the spectrum of the sterculic acid as the colour of the solution intensified. Simultaneously a new band seemed to appear gradually (it was somewhat obscured by the heavy carbon disulphide absorption starting here) near 6·15μ; this is in the C=C double bond region of the spectrum, and suggests that, as with the polymerization[1], the reaction involved an opening of the ring across the single bonds. Numerous other spectral changes were also observed, the most remarkable being the rapid appearance of a strong band at 4·88μ, which increased in intensity for several days but later decreased again. This spectral region is normally very empty, and no mention was found in the literature of a likely group absorbing here, even though the band was very strong and sharp. The absorption has been tentatively assigned to the double bond in the grouping

—S—C=S, which is first formed by reaction between the carbon disulphide and the *cyclo*propene ring, and afterwards polymerizes across the C=S double bond. Another unknown broad band appeared progressively at 12·95μ: this is probably an antisymmetric C—S stretching absorption, which would predominate over the symmetric vibration in the polymer because of the unusual alternation of several carbon and sulphur atoms.

The exact mechanism of this reaction has not yet been established; but further investigation is proceeding.

I wish to thank Dr. J. C. Smith for providing the various samples of acids for infra-red analysis and the Scientific and Research Department, ISCOR, Pretoria, for the use of its infra-red spectrophotometer. This communication is published by permission of the South African Council for Scientific and Industrial Research.

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Constitution of Chaksine

In the course of investigations on the constitution of the quaternary base chaksine, $C_{11}H_{21}O_3N_3OH$, isolated from *Cassia absus*, Linn.[1], pyrolytic degradation of its iodide has been studied. On pyrolysis with silver or copper filings, at 310–320° C., in a nitrogen atmosphere, it gave ammonia, carbon dioxide and an oily product of deep red colour and soluble in ether, with a strong caraway-like smell, in about 10 per cent yield. This product on boiling with 20 per cent methanolic potassium hydroxide for 12 hr. yielded an acid soluble in petrol-ether (60°–80° C.) (melting point, 116° C. dec.) and an oily phenolic fraction soluble in petrol-ether. On using electrolytic copper in place of silver or copper filings in this degradation, the resulting ether-soluble oily product gave on hydrolysis, under the conditions described above, no acid soluble in petroleum ether but a much larger yield of the acid melting at 195° C. (dec.), which was identified as phthalic acid, finally through its anhydride. Accounting as it does for 8 out of 11 or possibly 12 carbon atoms of chaksine[1], this finding marks a significant stage in the elucidation of its constitution.

Full details of this work and other findings relating to investigations on the constitution of chaksine are being communicated elsewhere.

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Absorption Spectra of Free PH_2 and PD Radicals

Although a large number of diatomic free radical spectra are known[1], very few spectra of polyatomic free radicals have been positively identified. The spectra are of interest since they are a potential source of information concerning the electronic states of these radicals and their dissociation energies, the vibrational and rotational constants of these states and their bond-lengths and bond-angles. The only polyatomic free-radical spectrum for which a vibrational and rotational analysis has been carried out is that of HCO [2] (and DCO), although partial analyses have been given for NH_2 [3,4], CF_2 [5,6], C_3 [7,8], SiC_2 [9], HS_2 [10], and a number of larger radicals, for example, CH_3O [11].

One powerful method for obtaining the spectra of free radicals in absorption utilizes the method of flash photolysis for the production of the free radicals, the White system of mirrors for obtaining long absorption paths, and a spectrograph of high resolving power for detecting fine absorption lines[2]. To obtain the best spectra, the maximum possible energy should be discharged through the photolysis flash tube in a time comparable to the life-time of the radical. In the 'microsecond' flash photolysis apparatus at Ottawa, ~ 1,000 joules of energy (40 μF., 7,000 V.) are discharged through the photolysis flash tube in 10–20 microseconds. The absorption spectrum is recorded by a second flash tube through which ~ 100 joules of energy (2 μF., 10,000 V.) are discharged, causing a continuum to be emitted for 3–5 microseconds.

The spectrum of PH_2 was observed during the flash photolysis of phosphine at ~ 5 mm. pressure. The half-life of the radicals under these conditions was ~ 50 microseconds. The length of the absorption path was 6 m. and the spectra were photographed in the second order of a 21-ft. grating spectrograph. Eleven bands were observed in the region 3600 to 5500 A. With fully deuterated phosphine (PD_3) prepared by the action of D_2O on PI_3, thirteen bands of PD_2 were observed in the same spectral region. Reproductions of the strongest PH_2 and PD_2 bands are given in Fig. 1.

The spectra are very complex, and as yet no rotational analysis has been carried out. The most characteristic feature is the clustering of groups of strong lines, probably Q branches, at regular intervals along the spectrum. The long wave-length edge of these strong groups has been used for the purposes of vibrational analysis; the vacuum wave numbers are given in Table 1. It is seen that the bands form regular progressions, the vibrational spacing varying from 887 to 976 cm.$^{-1}$ for PH_2 and from 626 to 690 cm.$^{-1}$ for PD_2.

Table 1. Vacuum Wave Numbers and Assignments of PH_2 and PD_2 Bands

v_2'	PH_2		PD_2	
	ν_{vac}	ΔG	ν_{vac}	ΔG
0	18,271·8		18,271·6	
1	19,223·1	951·3	18,961·9	690·3
2	20,160·7	937·6	19,646·4	684·5
3	21,089·4	928·7	20,322·6	676·2
4	22,004·9	915·5	20,995·8	673·2
5	22,906·5	901·6	21,661·7	665·9
6	23,795·4	888·9	22,318·9	657·2
7	24,682·8	887·4	22,966·4	647·5
8	25,587·9	905·1	23,603·0	636·6
9	26,526·5	938·6	24,230·3	627·3
10	27,502·9	976·4	24,856·8	626·5
11			25,490·8	634·0
12			26,146·2	655·4

Units: cm.$^{-1}$

The assignment of these new bands to PH_2 and PD_2 is based on (1) the method of production of the bands by the photo-dissociation of PH_3 and PD_3, (2) the isotope shift when hydrogen is replaced by deuterium, (3) the rotational fine structure, which is too complex for diatomic PH, (4) the observed vibrational intervals, which are rather low to be assigned to PH stretching frequencies but which may be reasonably assigned to PH_2 and PD_2 deformation frequencies, and (5) the similarity of the spectrum to that known for NH_2.

The spectra may be interpreted as long progressions of the bending frequencies of PH_2 and PD_2 in the upper electronic state of the bands. Provisional assignments of the quantum number v_2' for the bending vibration are given in Table 1. It is interesting to note that for low vibrational quantum numbers, the vibrational intervals decrease with increasing v_2', while for higher vibrational quantum numbers ($v_2' > 7$ for PH_2 and $v_2' > 9$ for PD_2), the vibrational intervals increase with increasing v_2'. The energy at which this transition occurs is the same for PH_2 as for PD_2, indicating that the transition is a function of the potential energy curve of the upper electronic state. With large values of v_2', the amplitude of the bending vibration will be considerable, and at sufficiently high quantum numbers a stage will be reached when the hydrogen or deuterium atoms come into close contact during part of the vibration. This will cause appreciable repulsive forces to operate and will

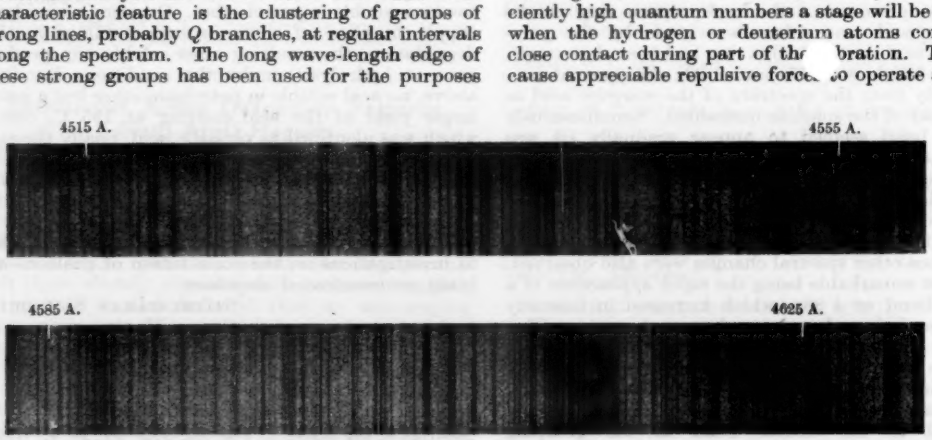

Fig. 1. Strongest absorption bands of PH_2 and PD_2 photographed in the second order of a 21-ft. grating spectrograph. The bands were observed during the flash photolysis of PH_3 and PD_3 at ~ 5 mm. mercury pressure. The length of the absorption path was 6 m.

result in an increase in the vibrational frequency. It is suggested that such repulsive forces are responsible for the observed increase in the vibrational frequencies of PH_2 and PD_2 at high vibrational quantum numbers.

I wish to thank Dr. G. Herzberg for helpful discussions.

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Paper Chromatography of Pyrethrins and their Derivatives

VARIOUS methods have been described for the chromatographic separation of pyrethrin-type compounds. Alumina, silica and kieselguhr have been used as adsorbents for separation of 'pyrethrin I' from 'pyrethrin II'[1-3]. A separation of cinerin I from 'pyrethrin I', and 'cinerin II' from 'pyrethrin II', has almost certainly been achieved by Ward[2], using displacement chromatography on alumina. The 'pyrethrins' have also been separated by paper chromatography using alumina-impregnated paper[1] and 'Vaseline'-impregnated paper[4]. Hitherto, untreated paper has only been used with success for the separation of the 'pyrethrin' 2,4-dinitrophenylhydrazones, using light petroleum (b.p. 80°–100° C.) as solvent[1]. The present communication records a simple chromatographic system for separating pyrethrin-type compounds on untreated paper.

The main problems associated with partition chromatography of the 'pyrethrins' arise from their partition coefficients being very much in favour of the less polar phase of the commoner liquid–liquid systems. The applicability of methods which have been used in the steroid field[5,6], where similar problems are encountered, has now been investigated. It is found that an ascending solvent system of light petroleum (b.p. 80°–100° C.) saturated with methanol gives good results with 'pyrethrins' on Whatman No. 1 paper; a similar system has previously been used for œstrogen separations[7]. It is essential to equilibrate the papers overnight in an atmosphere of the two solvent phases.

The time necessary for pre-equilibration of the papers can be shortened to one hour by operating under reduced pressure, as suggested by Winteringham *et al.*[8]. Their apparatus has been modified (Fig. 1) so as to handle volatile two-phase systems, and also to permit the starting of the chromatogram, after a desired equilibration period, without breaking the vacuum. Two paper strips are hung on the horizontal portion of the tube *B* and kept apart by clipping the lower ends around a piece of glass rod. The ends should come to within ½ cm. of the solvent at *D*. The apparatus is evacuated through *A* to an extent governed by the boiling points of the solvent phases in *C* and *D*. After a suitable equilibration period, the chromatogram is started by running in sufficient of the appropriate solvent phase from a funnel fitted into the ground-glass joint on *A*. The liquid is discharged down the side of the vessel from the tube *B*, which is tapered to a jet. The starting line on which the samples are applied is drawn 6 cm. up the paper on account of the initial speed of solvent migration. The R_F values for a number of the compounds run at room temperature and atmospheric pressure were:

'Pyrethrin I'	0·85
'Pyrethrin II'	0·70
± *trans*-Chrysanthemic acid	0·54
± *cis*-Chrysanthemic acid	0·56
Chrysanthemum dicarboxylic acid	0–0·04
Methyl pyrethrate	0·73
α-DL-*trans*-Allethrin	0·82
Allethrolone	0·09

Considerable quantities of material remained on, or near, the origin with old samples of 'pyrethrins', due undoubtedly to the presence of polymerized products. Under reduced pressure, R_F values were higher than those obtained at atmospheric pressure; for example, 'pyrethrin I', 0·94; 'pyrethrin II', 0·87.

The compounds were detected by two methods:

(*a*) A method due to Winteringham *et al.*[8], which consists of dipping the papers in 0·1 per cent aqueous potassium permanganate, washing free of permanganate with water and partially drying. The papers are then treated with 0·5 per cent benzidine in acetone containing 5 per cent glacial acetic acid. The manganese dioxide formed in the presence of unsaturated compounds shows as intense blue zones. This method gives excellent results, although more permanent and intense colour resulted from using 0·5 per cent benzidine hydrochloride in aqueous solution.

(*b*) Use of the light petroleum–methanol system (both solvents being free from aromatics) allows the

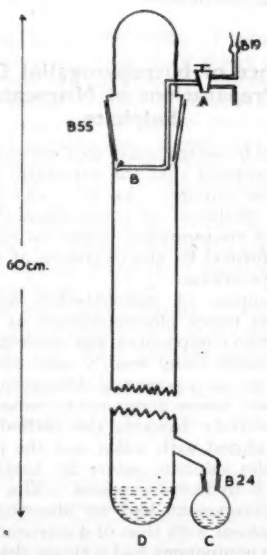

Fig. 1

technique of ultra-violet photography, which is widely used for derivatives of purine bases, to be applied. The pyrethrin-type compounds absorb strongly in the region of 230 mμ, due mainly to the *cyclo*-pentenolone grouping, and can be detected by exposure of the chromatogram, placed in contact with reflex document paper, to a Hanovia 'Chromatolite' ultra-violet lamp. The resulting photographs show the 'pyrethrins' as pale spots on a darker background. This technique, which cannot be applied to 'Vaseline'-impregnated paper, has the advantage that the separated compounds can afterwards be eluted unchanged from the paper. This method, however, is not so sensitive as method (*a*), a minimum of about 50 μgm. being needed; also, it does not detect chrysanthemic or pyrethric acids.

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Occurrence of Nitropyrogallol Disulphate in Preparations of Nitrocatechol Sulphate

During an investigation of ox-liver sulphatase *A* [1,2] it became apparent that the substrate, nitrocatechol sulphate, was impure. As this was prepared by persulphate oxidation of *p*-nitrophenol[3,4] it seemed that a likely contaminant might be nitropyrogallol disulphate, formed by the oxidation of the phenol in both *ortho* positions.

When samples of nitrocatechol sulphate were submitted to paper electrophoresis at *p*H 4·2 the presence of two components was obvious, the yellow nitro compounds being readily seen after drying at 110°. In 4 hr. at a potential difference of 250 volts the major and minor components moved 4 cm. and 9 cm. respectively towards the cathode. The two bands were eluted with water and the phenols liberated from the sulphate esters by heating for 1 hr. at 100° in *N* hydrochloric acid. The phenol from the major component had an absorption spectrum in alkali identical with that of 4-nitrocatechol[5]. That of the minor component had a single sharp maximum and 430 mμ and was identical with the absorption spectrum of authentic 5-nitropyrogallol, kindly provided by Dr. T. S. Gardner. Partition chromatography on paper[6] confirmed the identity of the two phenols with 4-nitrocatechol and 5-nitropyrogallol. The major component of the substrate was therefore nitrocatechol sulphate.

The sulphate contents of samples of the acid hydrolysate of the minor component were determined by Dr. J. W. Minnis. The samples contained 318 μgm. nitropyrogallol and yielded 1,017 μgm. barium sulphate. These results were consistent with the view that the minor component of the substrate was nitropyrogallol disulphate.

Colorimetric determinations of the two components following electrophoretic separation showed that of three routine preparations of nitrocatechol sulphate two contained approximately 10 per cent, and one about 0·1 per cent of nitropyrogallol disulphate. A preparation by Dr. Brian Spencer contained approximately 2 per cent of the disulphate. The effect of nitropyrogallol disulphate on the kinetics of nitrocatechol sulphate hydrolysis by sulphatase *A* is under investigation; but electrophoretically purified samples of nitrocatechol sulphate exhibit the same anomalous kinetics as do unpurified preparations.

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Modification of Glass Surfaces by *p*-Nitrobenzyl Bromide

In the course of a study on the nature of the surface hydroxyl group of silicate glasses, it has been found that glass surfaces become permanently hydrophobic after being treated for 1 hr. with a dry, 30 per cent toluene solution of *p*-nitrobenzyl bromide at a temperature of 100° C. The effect was found with vitreous silica, borosilicate glasses and glasses of other composition. The most pronounced results were obtained with glass surfaces which had been freshly cleaved under distilled water and vacuum-dried before treatment with the above solution. The treated surfaces remained hydrophobic after prolonged exposure to common organic solvents and water.

In order to obtain more information on the nature of the surface modification and especially in order to distinguish between chemical reaction and adsorption, comparative studies on glass surfaces treated with *p*-nitrobenzyl bromide and glass surfaces treated with aqueous solutions of the quaternary ammonium compound cetyl-pyridinium hydrochloride were made. The two types of surfaces were affected by prolonged

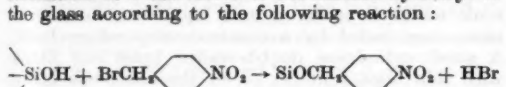
exposure to distilled water in distinctly different ways. The progress of the reaction between the surface and the water was followed by periodic measurements of the contact angle. A special apparatus was designed to measure the contact angles while the glass was continuously exposed to a stream of freshly redistilled water. The reproducibility of the measured contact angles was within 2 deg.

The hydrophobicity of a glass surface treated with *p*-nitrobenzyl bromide decreases slightly during the initial period of exposure, reaching a terminal value after sixty hours. After the terminal value is reached, no further decrease of hydrophobicity is observed. The hydrophobicity of the glass treated with cetylpyridinium hydrochloride, however, which is initially higher than that of glass treated with *p*-nitrobenzyl bromide, decreases continuously upon exposure to the distilled water, and the wettability of the surface approaches that of untreated glass surfaces.

The stability of the reaction product suggests the presence of an organic surface derivative of the glass, rather than an ion-exchange or adsorption layer, as is known to be the case with glass surfaces treated with quaternary ammonium compounds. The slight initial decline of the hydrophobicity of the glass surfaces treated with *p*-nitrobenzyl bromide at the beginning of the extraction is most likely to be due to the removal of adsorbed, unreacted *p*-nitrobenzyl bromide or other organic matter. It is unlikely to be caused by deposited layers of decomposition products of the *p*-nitrobenzyl bromide, for thin layers of this kind would gradually disappear upon extraction and thick layers would give a constant high value of hydrophobicity without any initial decrease. Experiments are under way to test this assumption.

The fact that in a further series of experiments no degree of hydrophobicity could be obtained by treating glass surfaces with *p*-nitrotoluene supports the view that the reactivity of the *p*-nitrobenzyl bromide depends on its $-CH_2Br$ group and not the nitro-group. Further, it is significant that glass surfaces which were prepared under conditions expected to yield the largest number of hydroxyl groups per unit surface area yielded the most hydrophobic products after being treated with *p*-nitrobenzyl bromide.

On the basis of the above experiments, it is proposed that the mechanism of the reaction is the formation of a derivative of the surface hydroxyl of the glass according to the following reaction:



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Regions of the Ionosphere responsible for Radio Star Scintillations

There is at present conflicting evidence as to the region of the ionosphere which is responsible for the scintillation of radio stars. Thus workers in the northern hemisphere[1,2] observing sources at fairly high angles of elevation, and also Mills and Thomas[3] in the southern hemisphere observing the Cygnus source at an altitude of 15°, have found a marked correlation between the occurrence of scintillations and of spread *F* echoes. On the other hand, Bolton *et al.*[4] at the same southern location as Mills, but observing sources within 10° of the horizon, found an equally marked correlation with sporadic *E*, but not with spread *F*.

We report here an analysis of some recent observations of scintillations[5], which appears to offer a solution to this problem. We find a correlation of night-time scintillations with spread *F* only, and of day-time scintillations with sporadic *E* only.

In the observations referred to, the source Cygnus *A* was observed from Dapto, New South Wales (lat. 34° 28·5′ S., long. 150° 47·5′ E.). The observations were restricted to ± 1 hr. from transit, when the altitude of the source is 15°. As reported earlier, the prevalence and intensity of scintillations vary markedly from day to day, but show two well-defined maxima, one when transit occurs near mid-day (December, summer), and one when transit occurs near midnight (June, winter) (Fig. 1). We are unable to determine whether these variations are diurnal or seasonal: for brevity, we shall refer to them as if they were diurnal.

In view of the occurrence of two such distinct maxima in the fluctuation index, the correlation between scintillations and ionospheric phenomena has been studied for day and night periods separately.

Day-time scintillations. Rays from Cygnus penetrate the *F* region (400-km. level) approximately 650 km. south-east of Townsville and 400 km. north-west of Brisbane, where routine ionospheric recorders are located. At no time during our day observations were spread *F* echoes reported from either of these stations.

For the *E* layer, the point of penetration lies 500 km. south-south-west of Brisbane and 500 km. north-north-east of Canberra, the nearest ionospheric recording stations. Table 1, which compares the sporadic *E* observed at these stations with the occurrence of scintillations, shows that the two are closely associated. There is a marked tendency for high fluctuation indices to occur when the critical frequency of sporadic *E* echoes is high. When the data are tested by either the χ^2 or the 'exact' test[6], it is found that the probability of the observed values occurring by chance if the two phenomena are independent is less than 1 in 10^4.

Because of the patchy nature of sporadic *E*, we have included in Table 1 only those days for which values of *fEs* (or *fE2s*) were available from both

Table 1. Correlation of Day-time Fluctuation Indices with Sporadic *E* at both Brisbane and Canberra. The Figures give the Number of Observing Days falling within the Different Categories

Fluctuation index	*fEs* (and *fE2s*) > 5 Mc./s. at either Brisbane or Canberra	*fEs* (or *fE2s*) > 5 Mc./s at both Brisbane and Canberra
0	15	3
1, 2 or 3	5	18

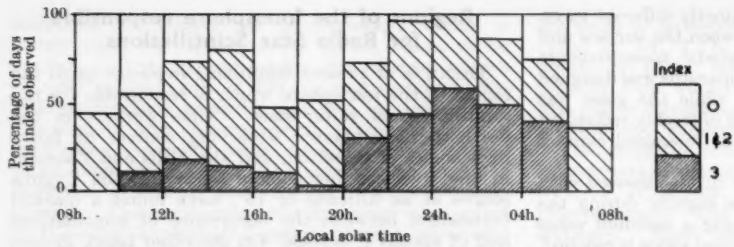

Fig. 1. Solar time variation of the fluctuation index. The index measures the prevalence and intensity of fluctuations on a scale increasing from 0 (no fluctuations) to 3 (very severe fluctuations). The observing days have been grouped according to the 2-hr. period in which transit occurred. Observations were made on 227 days during September 1952–February 1955

Brisbane and Canberra and for which either : (*a*) no value of *fEs* (or of *fE2s*) in excess of 5 Mc./s. was found at either of these stations during our observing period, or (*b*) a value of *fEs* (or *fE2s*) greater than 5 Mc./s. was recorded at both stations during our observations. The value 5 Mc./s. was chosen to divide the data into approximately equal parts : similar considerations decided the grouping of fluctuation indices used in Table 1.

Night-time scintillations. For night-time scintillations the correlation with spread *F* at Townsville is given in Table 2. In this case there is clearly a close association between the occurrence of high fluctuation indices and the appearance of spread *F*. According to either of the statistical tests mentioned, the probability of the figures occurring by chance alone is less than 1 in 10^6. There is a similar, but rather weaker, correlation with spread *F* at Brisbane.

Table 2. Correlation of Night-time Scintillations with the Occurrence of Spread *F* at Townsville

Fluctuation index	No spread *F*	Spread *F*
0 or 1	32	8
2 or 3	11	32

The results for sporadic *E* are given in Table 3, which shows no evidence of any correlation with night-time scintillations. Here 3 Mc./s. has been taken as the dividing value of *fEs*, again on the basis of separating the data into approximately equal parts. Other values were tried, and also other groupings of the fluctuation index, but none showed any evidence of a correlation between the two phenomena. The probability of figures such as those in Table 3 occurring by chance in uncorrelated data is about 0·6.

Table 3. Night-time Scintillations compared with Sporadic *E* at Brisbane and Canberra

Fluctuation index	*fEs* (and *fE2s*) $\not>$ 3 Mc./s. at either Brisbane or Canberra	*fEs* (or *fE2s*) > 3 Mc./s. at both Brisbane and Canberra
0 or 1	12	9
2 or 3	15	15

These results suggest that night-time scintillations arise in the *F*-layer and day-time scintillations in the *E*-layer. They are consistent with the observation that, at night-time only, there is a pronounced west-to-east component (some 80 m.sec.$^{-1}$) in the motion of the scintillation patterns across the ground[5]. Such a motion would be caused by the Earth's rotation if the irregularities were located at a height of about 500 km. and did not drift. It may also be noted that the current conception of sporadic *E* irregularities in terms of thin horizontal strata is in agreement with the fact that day-time scintillations have been reported only by workers observing at relatively low angles of incidence.

The ionospheric data for this analysis were taken from "Ionospheric Predictions, Series D", supplied by courtesy of the Ionospheric Prediction Service of the Australian Commonwealth Observatory.

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Ultrasonic Absorption in Liquids from Thermal Steady States

In a recent communication[1] in *Nature*, we confirmed a new method developed in this Laboratory for the determination of ultrasonic absorption (α) in liquids. Subsequent work[2] has shown that the quantities of energy absorbed in cells, of small lengths, placed in the path of the sound beam with their incident faces occupying identical places, are in the proportion of their lengths. Utilizing this idea, we have evolved yet another technique for the measurement of α in liquids.

In this new method, a fairly strong beam of ultrasonic waves is produced in a liquid contained in a tank, surrounded by a constant-temperature bath. A small cylindrical double-walled brass cell fitted with thin mica windows to let the ultrasonic beam in and out of the cell is filled with the same liquid as that contained in the tank. The cell is placed coaxially in the path of the ultrasonic beam and, due to continuous passage of the ultrasonic beam through the liquid, the latter heats up, reaching a constant temperature when the heating of the liquid is balanced by the conduction loss. The temperature-difference in the steady state between the liquid in the cell and that in the tank is measured accurately by means of a sensitive thermocouple arrangement. If I_0 is the intensity of the ultrasonic beam on entering the first mica window of the cell and θ_1 the steady deflexion in the galvanometer, then :

$$I_0\{1 - \exp(-2\alpha l)\} = K\theta_1$$

where α is the absorption coefficient of the liquid, l the length of the cell and K is a constant.

Similarly, if θ_2 is the steady deflexion when the cell is placed at a distance x from the first position, we have :

$$I_0 \exp(-2\alpha x)\{1 - \exp(-2\alpha l)\} = K\theta_2$$

The absorption coefficient can then be calculated from these relations ; thus

$$\alpha = \frac{\ln \theta_1 - \ln \theta_2}{2x}$$

Necessary precautions were taken for the proper alignment of the cell, so that its movement was along the axis of the sound beam. Reflexion of the ultrasonic waves from the remote end of the large tank was also avoided.

This technique has been used for determining the absorption coefficient of ultrasonic waves at 5 Mc./s. in benzene, carbon tetrachloride, amyl acetate and xylene, thus covering a wide range of absorption coefficients (Table 1). The values are in good agreement with those obtained by other methods[3]. It is seen from the results that the method is capable of a high degree of accuracy, as the values can be reproduced to within ± 5 per cent of the mean value.

Table 1

Liquid	Temp. (° C.)	$a/\nu^2 \times 10^{17}$ at 5 Mc./s.	Average	$a/\nu^2 \times 10^{17}$ by other methods (ref. 3)
1. Benzene	19	849 766 820	812	900 at 22° C.
2. Carbon tetrachloride	18	422 414 416	417	500 at 20° C.
3. Amyl acetate	19	183 177 178	179	166 at 29° C.
4. Xylene	18	95 92 91 96	94	78 at 25° C.

A detailed paper will be published elsewhere.

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Unit-cell Dimensions and Space Group of 6-Mercaptopurine Monohydrate

Recent studies have directed attention to the possible chemotherapeutic activity of 6-mercaptopurine. The compound has been synthesized[1] and found to be a purine antagonist in *Lactobacillus casei*[2]. It acts as a moderate inhibitor on sarcoma 180 [3] and on some types of carcinoma[4]. A preliminary X-ray investigation of the substance was undertaken in view of its biochemical importance.

A sample of 6-mercaptopurine was given to us by Dr. Leonard Hamilton, of the Sloan-Kettering Institute for Cancer Research ; crystals were obtained from hot saturated aqueous solution upon slow cooling in a Dewar flask. Most of the crystals were yellow needles, elongated in the *c*-axis direction, with forms {0 0 1}, {1 1 0}, and sometimes {1 0 0} developed.

The crystals are monoclinic. Unit-cell dimensions were derived from rotation photographs and from zero-layer and first-layer Weissenberg photographs taken about the *b*- and *c*-axes with copper $K\alpha$ radiation. The crystallographic data obtained are listed below (together with their standard deviations).

$a_0 = 15{\cdot}29 \pm 0{\cdot}03$ A. $\quad \beta = 102° 24' \pm 15'$
$b_0 = 7{\cdot}76 \pm 0{\cdot}02$ A. $\quad$ Density (by flotation) = 1·574 gm. cm.$^{-3}$
$c_0 = 12{\cdot}43 \pm 0{\cdot}04$ A. $\quad$ Space group, $C_{2h}^6 - C2/c$

Each unit cell contains eight molecules (calculated 8·07 for 6-mercaptopurine.$1H_2O$).

Because of the unfavourable dimensions of the unit cell, a complete determination of the structure of this crystal is not contemplated at present.

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Magnetic Properties of Ferrichrome and Ferroverdin

Some time ago, Neilands and his associates isolated from the smut fungus, *Ustilago sphaerogena*, two pigments which he called ferrichrome[1] and ferrichrome *A* [2] because of their red colour and iron content (7·35 and 5·3 per cent respectively). Both ferrichromes have probably one iron atom per molecule and are soluble in phosphate buffer in a presumably monomeric form[3]. They are easily decolorized by hydrosulphite and the reduced forms are autoxidizable[1,2]. The ferrichromes are also bleached by treatment with great excess of strong ferric ion-binding reagents, such as thenoyltrifluoracetone and versene. The red colour is restored on addition of ferric ions, or of ferrous ions in the presence of oxygen (Neilands, J. B., personal communication). There is thus very strong evidence that the iron in the oxidized ferrichromes is trivalent. Magnetic measurements were undertaken in order to confirm this and to elucidate the structure of the complexes.

The paramagnetic susceptibilities of the compounds and their reduced derivatives were determined in 0·1 *M* phosphate buffer, *p*H 6·9, at 20° C. No diamagnetic corrections were made and Curie's law was assumed to be valid in the calculation of the effective magnetic moments. The results are given in Table 1.

The values for the oxidized ferrichromes are in the region expected for trivalent iron with five unpaired electrons. The decrease in susceptibility of about $3{,}500 \times 10^{-6}$ c.g.s. e.m.u. upon reduction is typical of a change from fully paramagnetic trivalent iron to fully paramagnetic divalent iron. If the decrease had been due to the disappearance of a free

Table 1

Compounds	χ (iron) (c.g.s. e.m.u. $\times 10^{-6}$)	μ_{eff} (Bohr magnetons)
Ferrichrome	13,630	5·68
" + sodium dithionite	10,270	4·93
Ferrichrome *A*	13,860	5·73
" + sodium dithionite	10,270	4·93

radical in the organic molecule, it would have been expected to be only about $1{,}300 \times 10^{-6}$.

The susceptibility values indicate further that only weak covalent bonds are involved around the iron, since all the 3*d* orbitals are occupied by unpaired electrons.

When 1 *M* fluoride was added to ferrichrome at *p*H 6·9, no change in spectral absorption or magnetic susceptibility could be observed. This behaviour contrasts with that of methæmoglobin or metmyoglobin, in which a co-ordinated water molecule is believed to be replaced by fluoride. It cannot be concluded, however, that water molecules or hydroxyl ions are not co-ordinated to the iron of ferrichrome.

Ferrichrome reduced by dithionite at *p*H 9·5 in presence of 0·1 *M* potassium cyanide was found to be completely diamagnetic. According to Neilands, aeration of such a sample does not restore the colour[2], and this has been confirmed. Addition of ferric ions, however, brought back the colour. The sample also gave the usual reactions of ferrocyanide upon acidification. The most likely explanation is that all the ferrous iron takes part in the formation of diamagnetic ferrocyanide; if a cyanide compound of ferrous ferrichrome exists to any extent in equilibrium with the ferrocyanide, it must be diamagnetic, have strong covalent bonds and be non-autoxidizable, but still be easily converted into ferrocyanide, properties that seem to be somewhat contradictory.

Recently, Chain *et al.* isolated from a new type of streptomycete another pigment of quite a different character[3]. Because of its iron content (9·3 per cent) and green colour they named it ferroverdin. It is insoluble in water but soluble in many organic solvents. When the pigment is reduced catalytically by hydrogen, twelve equivalents are used up and the green colour disappears and does not come back upon aeration[3]. The iron might thus be either divalent or trivalent; but the present investigation makes it possible to decide this question and also to draw some conclusions about the structure of the complex.

The magnetic susceptibility of the iron of ferroverdin was found to be 125 ($\pm$ 160) $\times 10^{-6}$ c.g.s. e.m.u. in methanol solution and 20 ($\pm$ 80) $\times 10^{-6}$ in ethylene glycol solution without any diamagnetic corrections being made. The preparation used contained only 6·6 per cent iron, and therefore the correction would not exceed 700×10^{-6} even if the partial specific volume of ferroverdin were equal to zero. A ferric compound with one unpaired electron should give a paramagnetic susceptibility of at least $1{,}300 \times 10^{-6}$. It may thus be concluded that the iron of ferroverdin is divalent and diamagnetic, and that two of the 3*d* orbitals are involved in covalent bonding. The complex is probably octahedral with d^2sp^3 bonds, and in this case, since ferroverdin contains no sulphur and only two nitrogen atoms per iron atom[3], at least four of the six chelating groups have oxygen or carbon co-ordinated to the iron by covalent bonds.

Ferroverdin in glycol solution reacted with hydrosulphite upon gentle heating. The colour turned brownish and the susceptibility increased to 9,500 $\times 10^{-6}$. This implies that the covalent bonds are weakened or released under these conditions.

I am indebted to Dr. J. B. Neilands for the ferrichrome samples, to Prof. E. B. Chain for a sample of ferroverdin, and to Prof. H. Theorell for his interest in the work.

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Feb. 9.

[1] Neilands, J. B., *J. Amer. Chem. Soc.*, **74**, 5848 (1952).
[2] Garibaldi, J. A., and Neilands, J. B., *J. Amer. Chem. Soc.*, **77**, 2429 (1955).
[3] Chain, E. B., Tonolo, A., and Carilli, A., *Nature*, **176**, 645 (1955).

Internally Coated Cathodes

Recent publications[1] have indicated that internally coated cathodes would be useful as sources of annular, high current-density electron beams in millimetre wave-length klystrons. For this application their behaviour in magnetic confining fields and their life are important. To study these factors, the cathode shown in Fig. 1 was used; in the first set of experiments, cathodes were made from 'O' nickel and coated with a standard triple-carbonate mixture. Cathode temperatures were measured with 0·005 in. diameter platinum–platinum 13 per cent rhodium thermocouples.

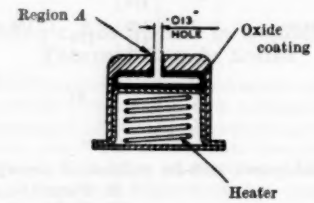

Fig. 1. Geometry of an internally coated cathode

Fig. 2 shows current-voltage properties of the cathode, some of which have already been reported[2]. The current, which after a rapid initial rise increases linearly with voltage, is greater than the space-charge-limited current obtainable from a conventional cathode of the same area, and no evidence of saturation has been found up to fields of 50 kV./cm. Abnormally high cathode temperatures are required, however, to obtain high current-density beams. When immersion magnetic fields are applied, the form of the characteristic is unaltered, but the current obtainable at a given voltage and temperature decreases linearly with field; the maximum observed decrease was about 20 per cent at 3,800 gauss. Characteristics were studied over the ranges of current and temperature shown in Fig. 2 using d.c. voltages, and pulsed voltages of 1 m.sec. duration with duty cycles from 0·1 to 0·002; identical results were obtained.

At values of magnetic field and current used (less than 2,000 gauss, 10 m.amp., 6 kV.) the beam is annular, though cross-section studies[3] show that the peripheral distribution of current is not uniform. The

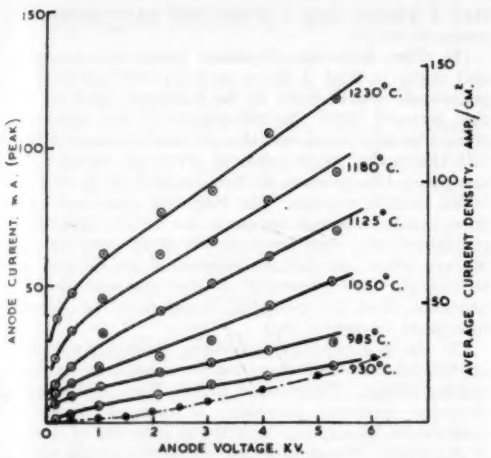

Fig. 2. Current-voltage characteristics of an internally coated cathode, with zero magnetic field: ———, experimental curves; — — —, space-charge-limited current for an 'equivalent' diode

annular characteristic becomes less pronounced at higher values of magnetic field and current.

At 900° C., lives of 1,000 hr. were obtained at 5 amp./cm.[2] (assuming uniform emission over the aperture). At higher temperatures, lives were impractically short, for example, 10 hr. at 1,100° C., and were independent of the current-density drawn (5 amp./cm.[2] to 50 amp./cm.[2]). Examination of valves opened after testing showed that a layer of nickel had formed over the edges of the coating (region *A* in Fig. 1), at points where this lay slightly below the metal surface.

It has been suggested[1] that emission arises mainly from coating at the edges of the aperture. The present investigations support this in that (1) covering the coating near the aperture significantly reduces the emission, (2) the beam is annular at low currents, and (3) strong immersion fields cause only slight reductions in current. An explanation for the magnitude of the observed currents may also be given. Beam cross-section studies with small plane cathodes have shown that currents considerably greater than the space-charge-limited values may be obtained. With a 0·050-in. diameter cathode at 900° C. the current-density in an annulus 0·006 in. wide near the edge was about six times the space-charge-limited value. Thus edge effects can predominate in the internally coated cathode, because the width of the emitting area is generally small (0·002 in.); hence currents much in excess of the space-charge-limited values might be expected.

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[1] Mueller, G. E., *Trans. Inst. Rad. Eng.* (*Electron Devices*), **4**, 33 (1953). Kumpfer, B. D., and Brett, H., Convention Record Inst. Rad. Eng., Pt. 3, 66 (1954).
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Irreversibility and Mechanics

Prof. K. R. Popper has recently pointed out the error in the belief that " 'classical' mechanics . . . can describe physical processes only in so far as they are reversible in time"[1]. He cites the spreading of water waves resulting from a dropped stone as an example of a 'classical' process which is irreversible. This example is, however, not altogether convincing, since it is not obvious that a reversed set of water waves cannot be set up by a system of generators, coherently operating on the periphery of the water wave system; also, the propagation of water waves is in any event irreversible by virtue of being a dissipative process, while Popper's argument was for irreversibility of the waves on other grounds.

Morpurgo, Radicati and Touschek have discussed[2] time reversal, using the following definition. Let $\mathbf{r}$ be the position vector of a particle and $\dot{\mathbf{r}}$ its velocity; the property of time symmetry, or invariance under time reversal, requires that if equations of motion lead in a time interval t from a state $\mathbf{r}_1$, $\dot{\mathbf{r}}_1$ to a state $\mathbf{r}_2$, $\dot{\mathbf{r}}_2$, then in the same interval they also lead from $\mathbf{r}_2$, $-\dot{\mathbf{r}}_2$ to $\mathbf{r}_1$, $-\dot{\mathbf{r}}_1$. Using this definition as a criterion for path reversibility, we find that a clear example of lack of reversibility in mechanics is provided by certain solutions of the equation of Newton's second law.

We may write the law in the simple one-dimensional form,

$$F = m\ddot{x} \qquad (1)$$

where F is a force in the x direction and m is a mass. Equation (1) is time reversible in the sense that it is the same with the use of either two positive or two negative differential increments of time. Further, (1) is reversible in that if it is integrated with an F that is a function of x, the path obtained after a velocity reversal is the reverse of the original path, as required by our adopted definition of path reversibility. Thus, with a gravitational force which is an $F(x)$, we have path reversibility. If, however, F is a function of t, one does not obtain such reversibility in the solution of (1), as will now be shown.

We take m to be a constant, and write $F(t)/m$ as $a(t)$, so that (1) becomes $a(t) = \ddot{x}$. A first integration gives

$$\dot{x} = \int_0^t a(t)\mathrm{d}t + \dot{x}_i \qquad (2)$$

where $\dot{x}_i$ is velocity at $t = 0$ and $\dot{x}$ is velocity at t. A second integration gives:

$$x_f = \int_0^{t_f}\left[\int_0^t a(t)\mathrm{d}t + \dot{x}_i\right]\mathrm{d}t + x_i, \qquad (3)$$

where $x = x_i$ at $t = 0$ and $x = x_f$ at $t = t_f$. For the reversed motion, indicated by primed symbols, a first integration gives $\dot{x}' = \int_0^t a(t)\mathrm{d}t + \dot{x}'_i$. We integrate through the same time interval t_f as before, but with $\dot{x}_i' = -\dot{x}_f$ at $t = 0$, where $\dot{x}_f$ is the final velocity of the previous motion. A second integration, after replacement of $\dot{x}_i'$ by $-\dot{x}_f$ as determined from (2), gives:

$$x'_f = \int_0^{t_f}\left[\int_0^t a(t)\mathrm{d}t - \int_0^{t_f} a(t)\mathrm{d}t - \dot{x}_i\right]\mathrm{d}t + x'_i. \qquad (4)$$

Since x'_i is equal to x_f, we may substitute x_f as given by (3) for x'_i in (4). We then find for the final position, x'_f, in the reversed motion:

$$x'_f = \int_0^{t_f}\left[2\int_0^t a(t)\mathrm{d}t - \int_0^{t_f} a(t)\mathrm{d}t\right]\mathrm{d}t + x_i. \qquad (5)$$

It is apparent from (5) that, with an $F(t)$, solutions of (1) will not in general have the property of path reversibility; for the reversed motion does not, after time t_f, give $x'_f = x_i$. (A sinusoidal force, $F = b\sin\omega t$, provides a simple example of an $F(t)$.) In the special case that $a(t)$ is a constant, (5) reduces to $x'_f = x_i$; and, as noted, we do have path reversibility when (1) is solved with an $F(x)$. It appears that motions under various kinds of physical forces must be individually examined for their reversibility properties.

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[1] Popper, K. R., *Nature*, **177**, 538 (1956).
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Mr. R. Schlegel's definition of temporal reversibility, which he credits to Morpurgo, Radicati and Touschek, is clearly too narrow. It has to be extended, so as to cover a (conservative) physical system rather than one single particle.

Take the case of a planetary system: if we reverse the velocity of one of the planets, at the time t_f and at the position x_f, the planet will clearly not reverse its path precisely: upon reaching, at the time $t_f + \Delta t$, the position $x_f + \Delta x$, which we may assume to be very nearly the same as the one which it occupied at $t_f - \Delta t$, the planet will not be acted upon by the same force which acted upon it at the time $t_f - \Delta t$. If, however, we reverse the motions of all the planets in the system, then the force will be the same; the system is reversible.

This shows that the problem of reversibility or irreversibility arises only with respect to a (conservative) physical system. It is obvious that, in a classical model, the motion of one planet or of one particle cannot be reversed.

Mr. Schlegel proposes to consider the reversibility of the motion of one particle under the action of a time-dependent force. There are, clearly, two cases to be considered. In the first case, the temporal changes of the force in question are explicable (that is, deducible, or predictable) in terms of the changes within the system; in classical mechanics, in terms of the changing positions of the various particles. Classical mechanics is reversible in the sense that if the velocity vectors of all particles are reversed, the temporal and positional changes of the forces (but not their directions, of course) are also reversed, and all the particles return on the paths on which they came. In the second case, the changes of the force in question are not explicable in terms of the changes in the system. In this case, the problem of reversibility, and of the 'arrow of time', does not arise: irreversibility is trivial, except under the assumption that the temporal changes of the force are also reversed.

Mr. Schlegel operates with a changing force the changes of which he does not reverse. He therefore obtains the obvious result: the motion of his particle will not in general be reversible.

Concerning Mr. Schlegel's comments on my own communication, I wish to make four remarks.

(1) I have found since that nearly half a century ago, Einstein used a somewhat similar argument[1]. Had I known this, I would not have written my communication.

(2) The difference between Einstein's argument and mine is that I have pointed out (*a*) that the generators would have to be coherent, and (*b*) that the demand that the coherence of the generators should be explained, and the explanation incorporated into the model, must either be given up (which means accepting the process as irreversible) or it will lead to an infinite regress. Mr. Schlegel mentions coherence, but he does not appear to have fully appreciated my admittedly very brief sketch of the way in which we are led to an infinite regress, if we do not wish to accept the coherence of the generators as an ultimate and inexplicable conspiracy of causally unrelated conspirators.

(3) As to dissipating processes, there are two kinds of dissipation which do not always seem to be clearly distinguished. Dissipation in the form of increasing disorder (entropy increase) is one of them, and dissipation by expansion without increase of disorder is the other. For an increase of disorder, walls of some kind are essential: a sufficiently thin gas expanding in a 'vessel without walls' (that is, the universe) does not increase its disorder. In the absence of walls, collisions become rapidly extremely improbable, and the degree of order of the system begins to increase in time, in the sense that the fastest particles will all be found near the periphery of the expanding gas ball and the slowest particles near its centre. If this development is prevented by the insertion of 'walls' of some kind (the 'walls' may be gravitational fields preventing the escape of particles) then the disorder will increase.

(4) My earlier brief communication was merely an attempt to point out the untenability of the widespread, though surely not universal, belief that the 'arrow of time' is closely connected with, or dependent upon, the law that disorder (entropy) tends to increase. Beyond this, I did not attempt to cover the subject.

K. R. Popper

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[1] Einstein, A., *Phys. Z.*, **10**, 821 (1909).

Application of Impedance Measurements to Corrosion Phenomena

In connexion with a recent communication[1] it should be pointed out that the application of impedance measurements to corrosion phenomena is not new. Extensive measurements of the resistance and capacity of painted steel specimens have been carried out for a number of years[2] and have proved most useful in studying the breakdown of paint films.

In the course of this work, the possibility was raised of extending the method to other thin films such as anodic oxide films. The present work[1] demonstrates the usefulness of the method in the study of phenomena within oxide films formed during corrosion.

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Teddington, Middlesex.

[1] Wanklyn, J. N., *Nature*, **177**, 849 (1956).
[2] Wormwell, F., and Brasher, D. M., *Nature*, **159**, 673 (1947); see also "Chemistry Research, 1947", 11 (H.M.S.O., London, 1949); *J. Iron and Steel Inst.*, (2) **164**, 141 (1950), and **169**, 228 (1951).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

MAP CURATOR AND LIBRARIAN (preferably with qualifications in geography and in librarianship) IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Sheffield (August 25).

LECTURER (with a good degree in physics, teaching and research or industrial experience, and preferably special qualifications in some branch of applied physics) IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (August 25).

PLANT PHYSIOLOGIST (with a good honours degree in botany or agricultural botany)—The Registrar, University College of Wales, Aberystwyth (August 25).

CHEMISTS (with a first- or second-class honours degree) at the North Thames Gas Board's Chemical By-Products Works, Beckton, East Ham, London, E.6, for research on problems in connexion with coal tar distillation, and the manufacture of phenols, naphthalene and bases—The Staff Controller, North Thames Gas Board, 30 Kensington Church Street, London, W.8, quoting Ref. 666/288 (August 27).

ASSISTANT IN ELECTRICAL ENGINEERING—The Secretary of the University Court, The University, Glasgow (August 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Registrar, University College of Wales, Aberystwyth (August 31).

ASSISTANT LIBRARIAN (with some experience in a scientific or technical library) IN THE SCIENCE AND TECHNOLOGY SECTION of the University Library—The Librarian, The University, Edmund Street, Birmingham 3 (August 31).

DISTRICT (Forest) OFFICERS (with, or obtain in summer 1956, a university degree or diploma in forestry, or a postgraduate degree in a forestry subject)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting Ref. No. 146/56/1 (August 31).

LECTURER IN THE DEPARTMENT OF METALLURGY to lecture in X-ray metallography and the thermodynamics of alloys—The Registrar, The University, Liverpool (August 31).

LECTURER IN ANIMAL HUSBANDRY AND PREVENTIVE MEDICINE at the University Veterinary School—The Secretary of the University Court, The University, Glasgow (August 31).

LECTURER (preferably with experience in tropical plant physiology) IN PLANT PHYSIOLOGY at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (August 31).

ASSISTANT PHYSICIST, Basic grade (with a good honours degree in physics and preferably experience in electronics and nuclear physics techniques) IN THE PHYSICS DEPARTMENT of the Sheffield National Centre for Radiotherapy—The Secretary, Sheffield Regional Hospital Board, "Broom Cross", Tree Root Walk, Sheffield 10 (September 1).

BIOCHEMIST (with an appropriate science degree of a university of Great Britain or associateship of the R.I.C.) for duties at the Harrogate and District General Hospital and Royal Bath Hospital—The Group Secretary, Harrogate and Ripon Hospital Management Committee, Hereford Lodge, Cornwall Road, Harrogate (September 1).

PRINCIPAL (graduate of a British university, with teaching and, if possible, some administrative and industrial experience) OF BRADFORD TECHNICAL COLLEGE—The Director of Education, Town Hall, Bradford (September 1).

RESEARCH FELLOW (with a good honours degree either in engineering, physics or mathematics, and preferably some practical experience) IN ENGINEERING—The Registrar, The University, Nottingham (September 1).

SENIOR LECTURER IN THE DEPARTMENT OF NATURAL PHILOSOPHY—The Secretary, The University, Edinburgh (September 1).

DEMONSTRATOR IN GEOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (September 4).

LABORATORY ASSISTANT (preferably with laboratory experience) at Ealing Technical College—The Principal, Ealing Technical College, St. Mary's Road, Ealing, London, W.5, quoting "T.323.N" (September 10).

RESEARCH FELLOW or JUNIOR RESEARCH FELLOW (organic chemist with research experience, preferably on natural products) at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 10).

PHYSICIST or PHYSICAL CHEMIST (with an honours degree in physics and a good knowledge of instrumentation) to work in the new Research Department of Anæsthetics—The Secretary, Faculty of Anæsthetists, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (September 12).

UNIVERSITY DEMONSTRATOR (with an honours degree in pure science with organic chemistry and biochemistry as principal subjects) IN ANIMAL NUTRITION—The Secretary, School of Agriculture, The University, Cambridge (September 12).

SENIOR LECTURER (graduate in agriculture or pure science) in charge of an Agricultural Research Station to be established in the Forest Region of the Gold Coast (University College of the Gold Coast), for the study of soils and crop production—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 27).

HEAD OF THE DEPARTMENT OF PHYSIOLOGY; and a SENIOR PRINCIPAL SCIENTIFIC OFFICER IN THE EXPERIMENTAL PATHOLOGY DEPARTMENT—The Director, Institute of Animal Physiology, Babraham Hall, Babraham, Cambridge (November 15).

ASSISTANT PROFESSOR (with teaching experience and research interests in inorganic or physical chemistry) IN CHEMISTRY—Prof. C. A. McDowell, Department of Chemistry, University of British Columbia, Vancouver 8, B.C., Canada.

BOTANIST (with postgraduate research experience) for work on the seasonal accumulation, translocation and utilization of reserve materials in fruit trees, to extend the knowledge of tree growth, flowering and fruiting already being obtained by methods of growth analysis; and a BIOCHEMIST (with postgraduate research experience) for work on the metabolism of fruit plants—The Secretary, East Malling Research Station, near Maidstone, Kent.

CHEMICAL ENGINEER (with a degree in chemical engineering and research experience) at a research institute in Aberdeen for research on smell suppression in the manufacture of fish meal—The Herring Industry Board, 1 Glenfinlas Street, Edinburgh 3.

CHEMIST (with an honours degree in chemistry or agriculture with a strong chemical bias, followed by postgraduate training in soils work and general ecology) IN THE DEPARTMENT OF AGRICULTURE, Tanganyika, to work as a member of a team investigating soil fertility problems and surveying new development areas—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/8/20.

DEPUTY DIRECTOR (with good academic qualifications and record for research work, preferably experience of tropical tree crops, including cocoa, and the working of a research institute) OF THE WEST AFRICAN COCOA RESEARCH INSTITUTE, Gold Coast, to take charge of the research work and administration of the Institute's Substation at Ibadan, Nigeria—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.197/200/016.

LECTURER or ASSISTANT LECTURER (with a university degree in electrical engineering and practical experience in the electrical industry) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER (with a good honours degree in science or horticulture and preferably some postgraduate research experience) in HORTICULTURAL SCIENCE—The Registrar, The University, Bristol 8.

LECTURERS IN AGRICULTURE—The Bursar, Royal Agricultural College, Cirencester.

METALLURGIST, CHEMIST or PHYSICIST (with a degree), IN THE INFORMATION DEPARTMENT, for work dealing with every aspect of the recording and transmission of information on the extraction, manufacture and uses of non-ferrous metals and their alloys—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

PHYSICAL CHEMIST, Principal or Senior Scientific Officer grade (with a first- or second-class honours degree in physical or inorganic chemistry, and an experienced physical chemist with a special interest in thermodynamics), to direct a team engaged in research relating to reactors—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1206/34.

RESEARCH CHEMICAL ENGINEER (with a first- or second-class honours degree in chemical engineering or in chemistry, a strong interest in applied physical chemistry problems, and preferably some research experience in chemical engineering or physical chemistry), to undertake investigations into the chemical and chemical engineering aspects of new processes under development in the atomic energy field—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1227/34.

RESEARCH WORKERS (with a first-class degree in engineering, physics or applied mathematics and several years research experience) IN THE MECHANICAL ENGINEERING DEPARTMENT, for research on combustion involving the solution of theoretical problems by network analogue, etc., and experiments on flames—Dr. D. B. Spalding, Imperial College of Science and Technology, London, S.W.7.

SENIOR and JUNIOR RESEARCH FELLOWS (Chemists and Physicists) IN THE DEPARTMENT OF GLASS TECHNOLOGY, to work on the problems of the glassy state—Prof. R. W. Douglas, Department of Glass Technology, The University, Sheffield 10.

SENIOR LABORATORY STEWARD (male or female, preferably with some general experience in a laboratory and G.C.E. in physics) IN THE PHYSICS LABORATORIES—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics and background experience in solid-state physics with at least three years postgraduate research experience, and preferably experience of spectrography or electronics) to investigate certain physical aspects of the detonation of solid high explosives and of the propagation of intense shock waves through solids and gases—The Senior Recruitment Office, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1228/34.

SENIOR SCIENTIFIC OFFICERS (with an honours degree or equivalent, and preferably some industrial and technical experience); and SCIENTIFIC OFFICERS (preferably with an honours degree or equivalent), for work which will include research into problems connected with the coking industry, the preparation of technical reports, and may involve participation in operational research in the provinces from time time—The Secretary, The British Coke Research Association, 74 Grosvenor Street, London, W.1.

REPORTS and other PUBLICATIONS

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What We Are Doing, No. 4 (June, 1956). (Bulletin of the British Paper and Board Industry Research Association.) Pp. 32. (Kenley: British Paper and Board Industry Research Association, 1956.) [56

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